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1915.

"Textile Mercury" Annuals

THE

COTTON YEAR BOOK

AND DIARY

1915

(Formerly "The Textile Year Book—Cotton")

TENTH YEAR OF ISSUE

COMPILED (FOR "THE TEXTILE MERCURY")

BY

S. ECROYD

Member of The Manchester Association of Engineers.

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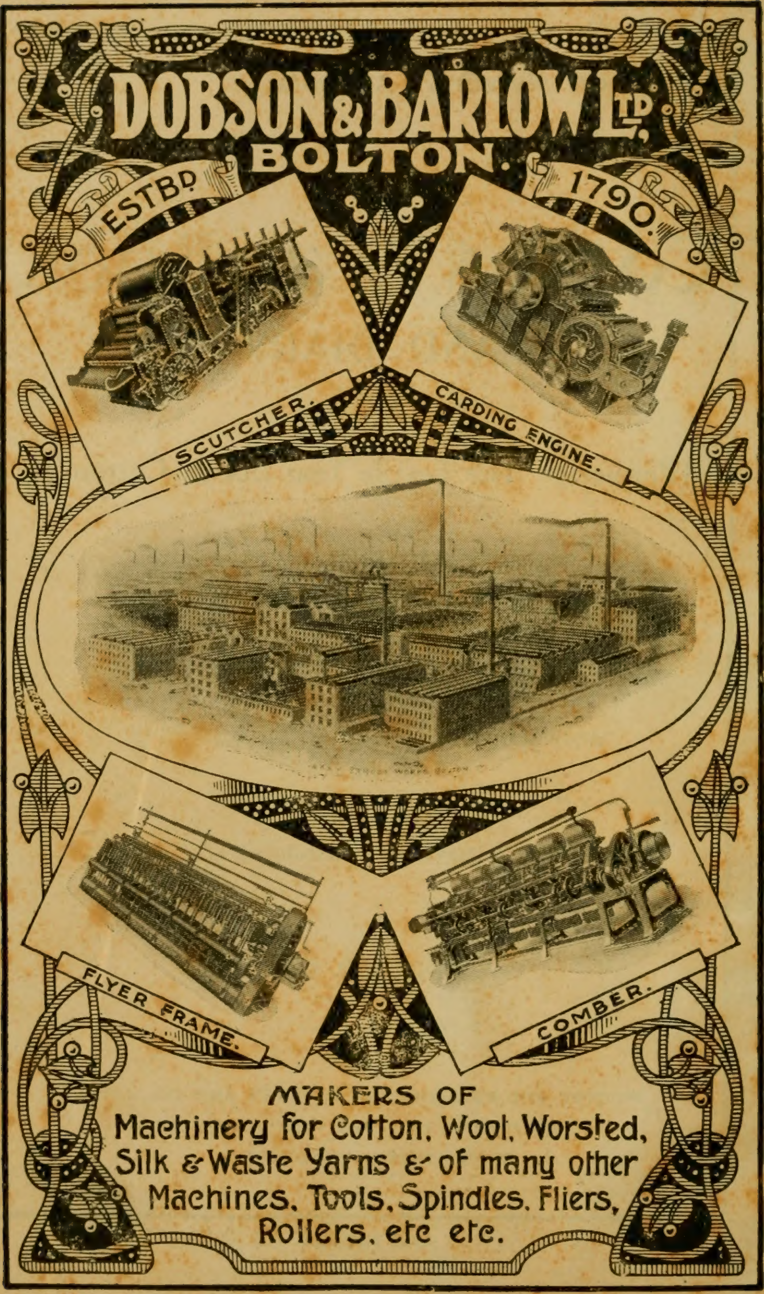
DOBSON & BARLOW LTD,
BOLTON.
ESTBD. 1790.
SCUTCHER.
CARDING ENGINE.
FLYER FRAME.
COMBER.
MAKERS OF
Machinery for Cotton, Wool, Worsted,
Silk & Waste Yarns & of many other
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Rollers, etc etc.

ESTABLISHED 1790.

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DOBSON & BARLOW LTD.,

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MAKERS AND PATENTEES

OF

MACHINERY

FOR

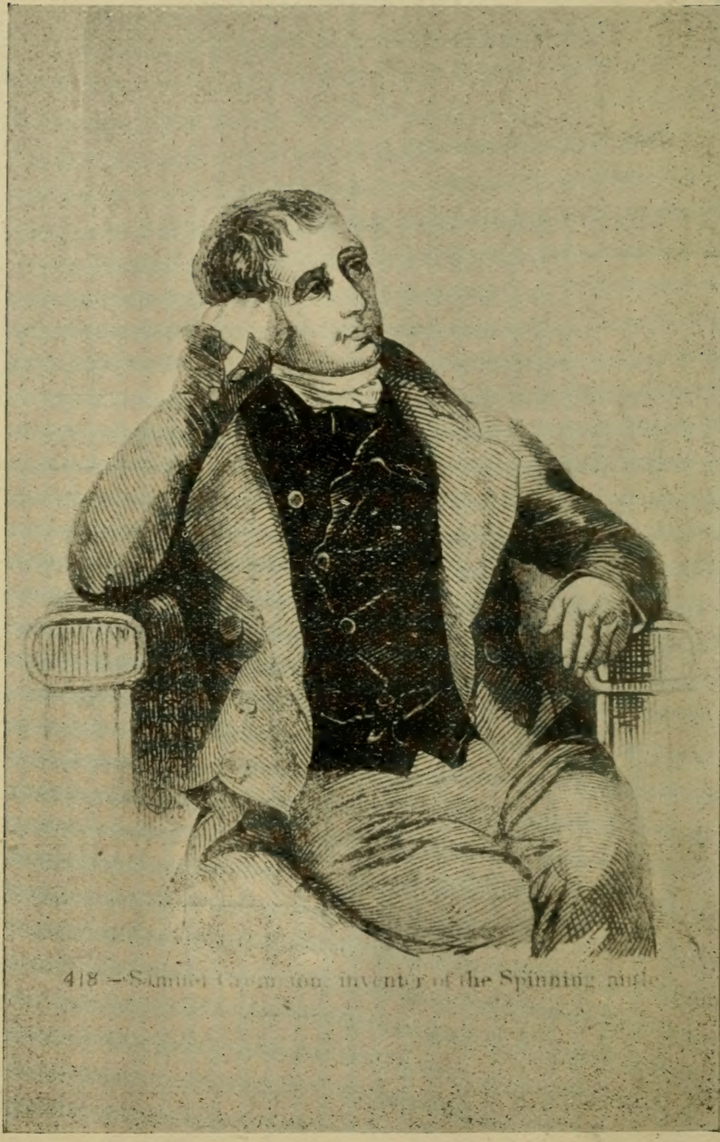
PREPARING, SPINNING, DOUBLING, WINDING,

REELING AND GASSING COTTON;

ALSO OF MACHINERY FOR

WOOL, WORSTED, SILK, AND WASTE YARNS.

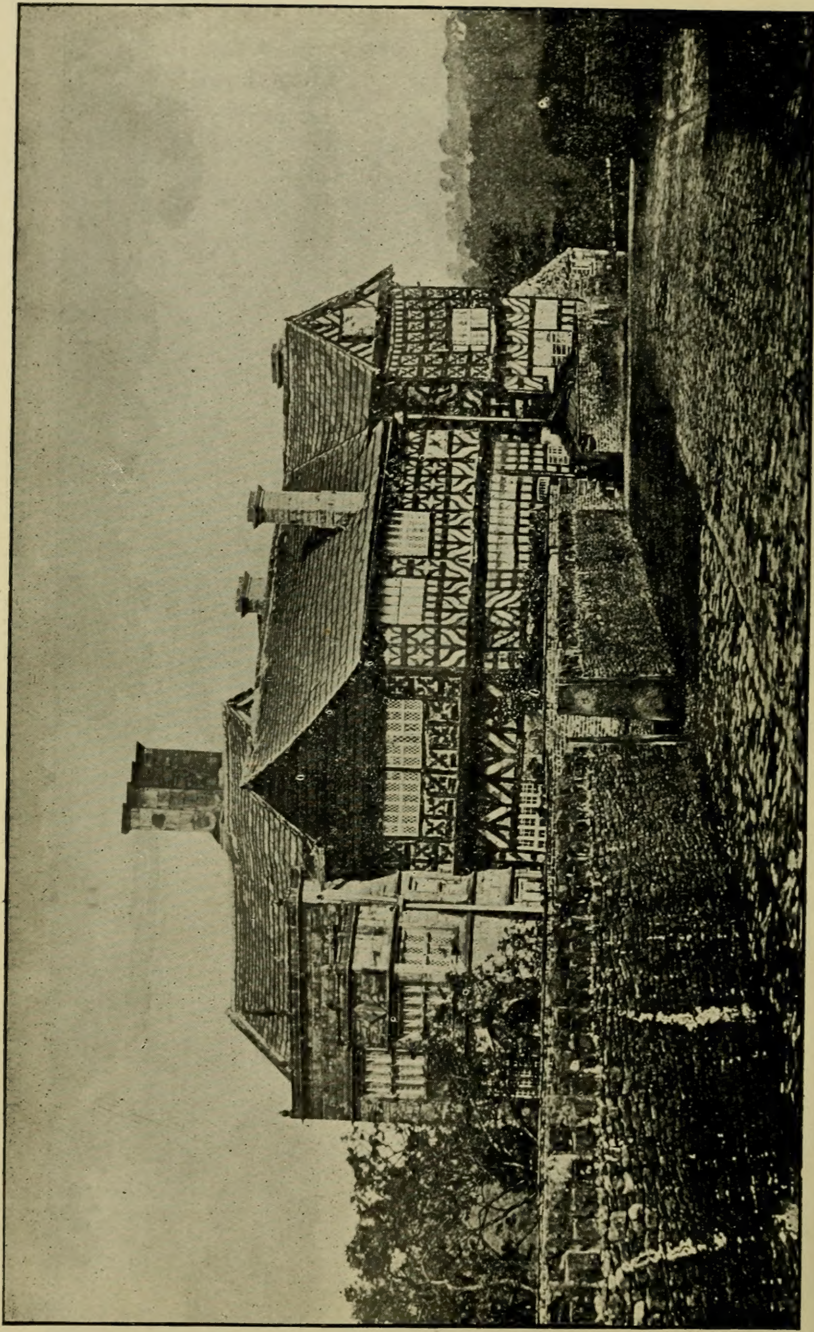
1915.



SAMUEL CROMPTON, OF BOLTON,

Inventor of the Spinning Mule.

FIRWOOD FOLD, BOLTON—BIRTHPLACE OF SAMUEL CROMPTON.

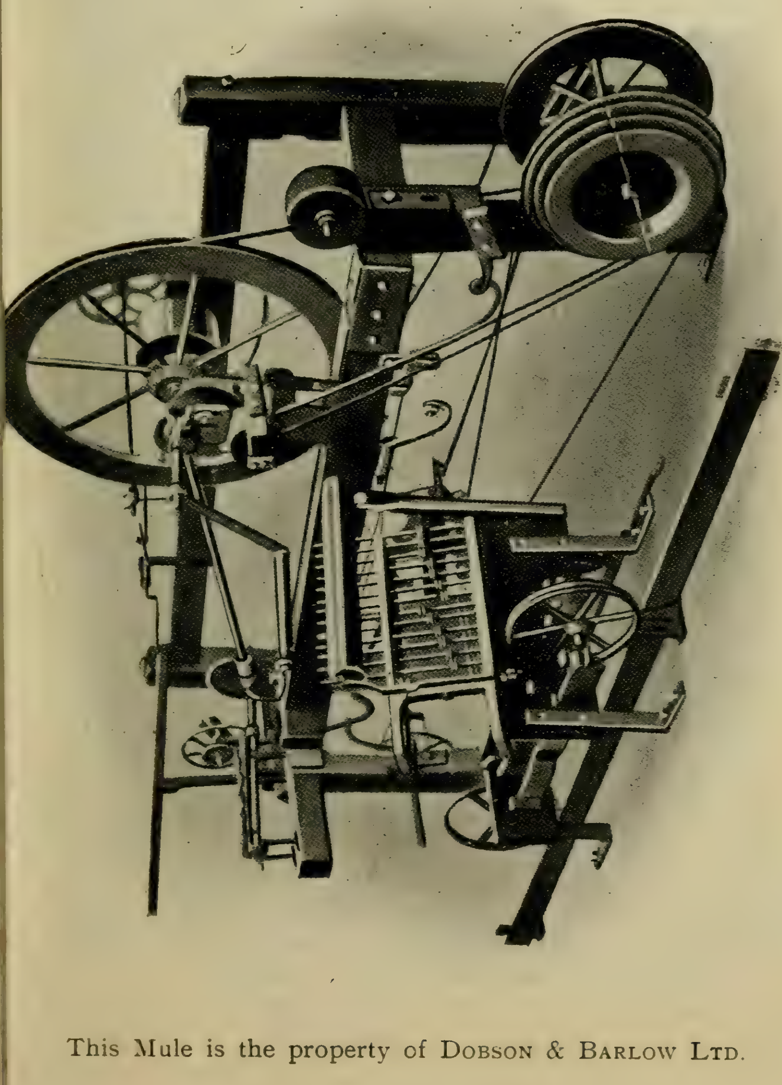


HALL-I'TH'-WOOD BOLTON—WHERE THE SPINNING MULE WAS INVENTED

IV.

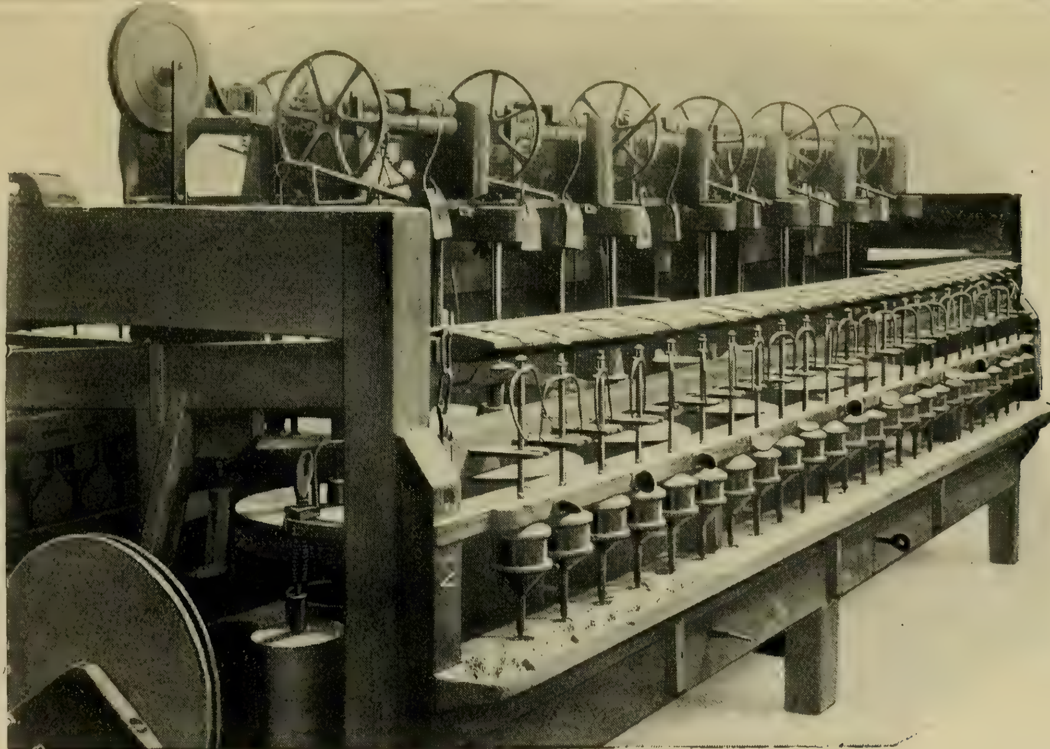
ORIGINAL SPINNING MULE

Invented, made, and worked upon by Samuel Crompton, Bolton.

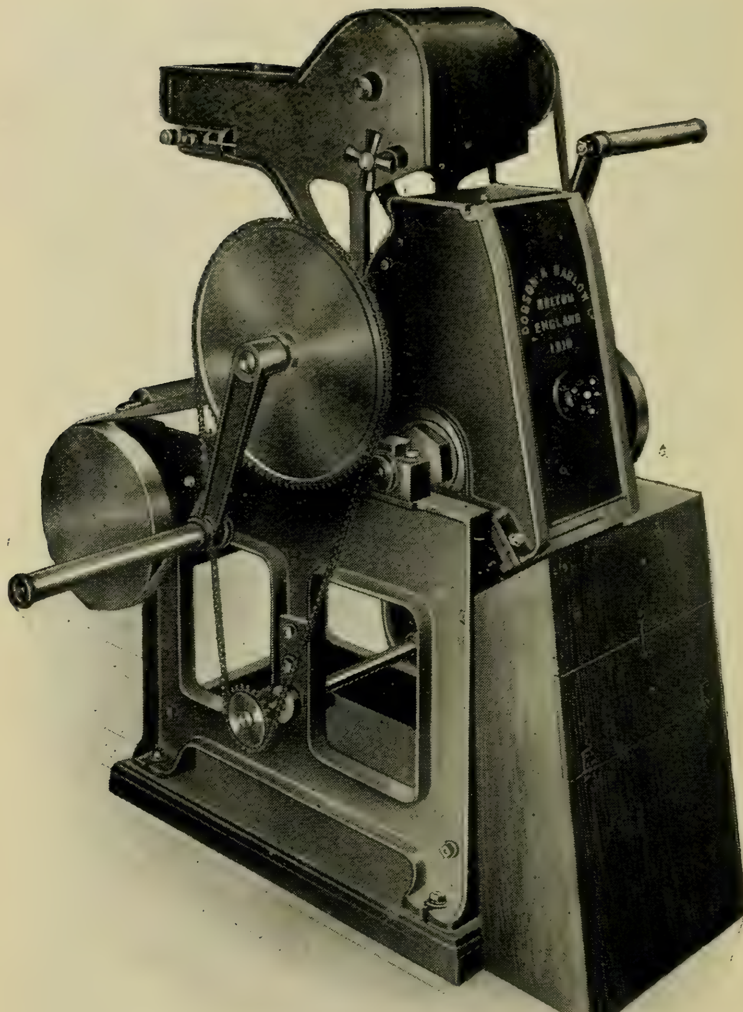


This Mule is the property of DOBSON & BARLOW LTD.

SIR RICHARD ARKWRIGHT,
Inventor of the Water Frame.



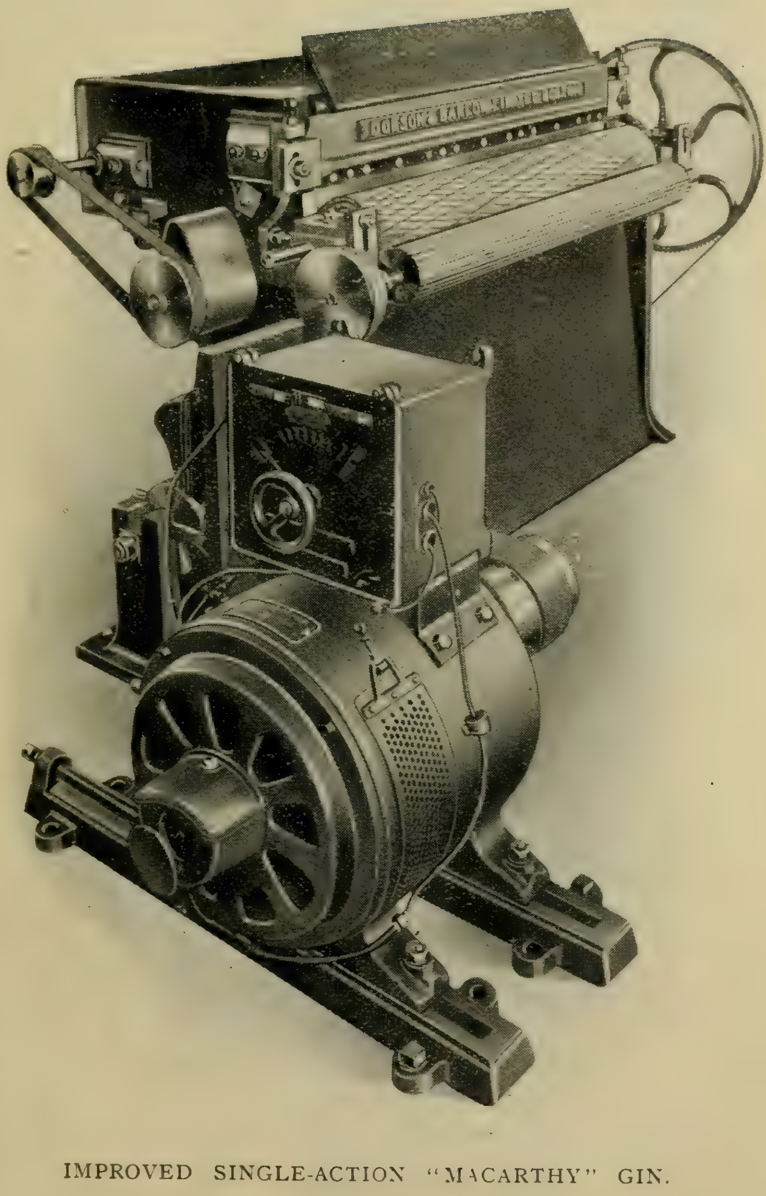
Copyright Photo] SIR RICHARD ARKWRIGHT'S WATER FRAME. [by W. W. Midgley.



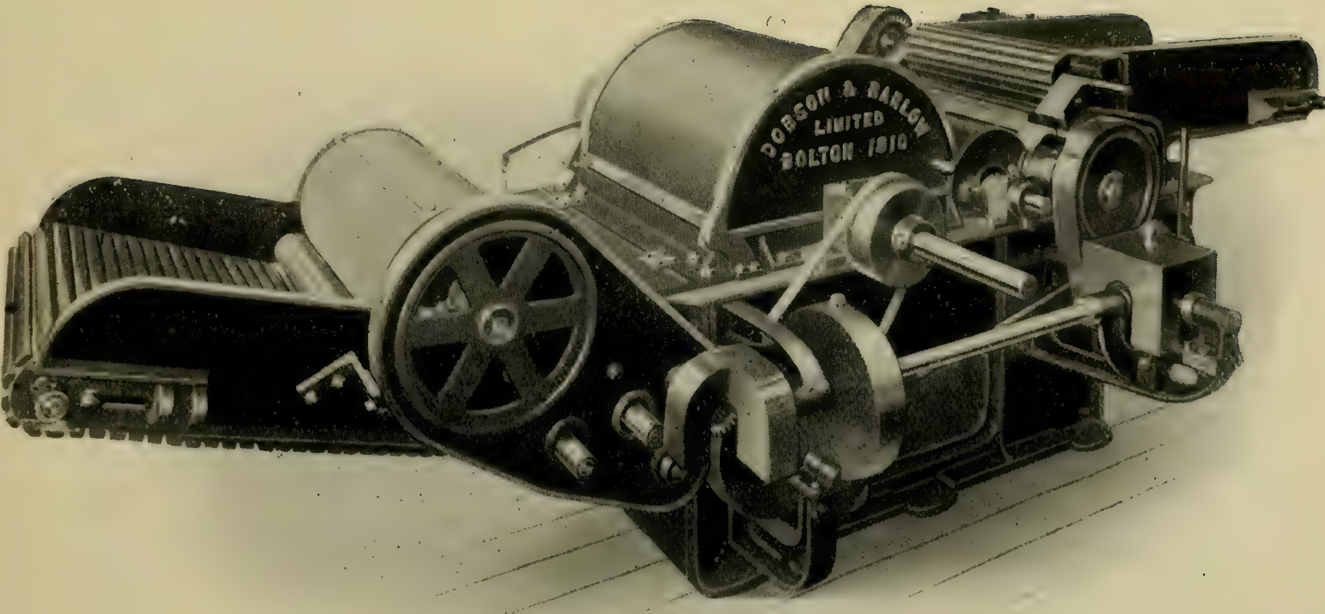
SAW GIN,

for driving by hand, with 10 saws.

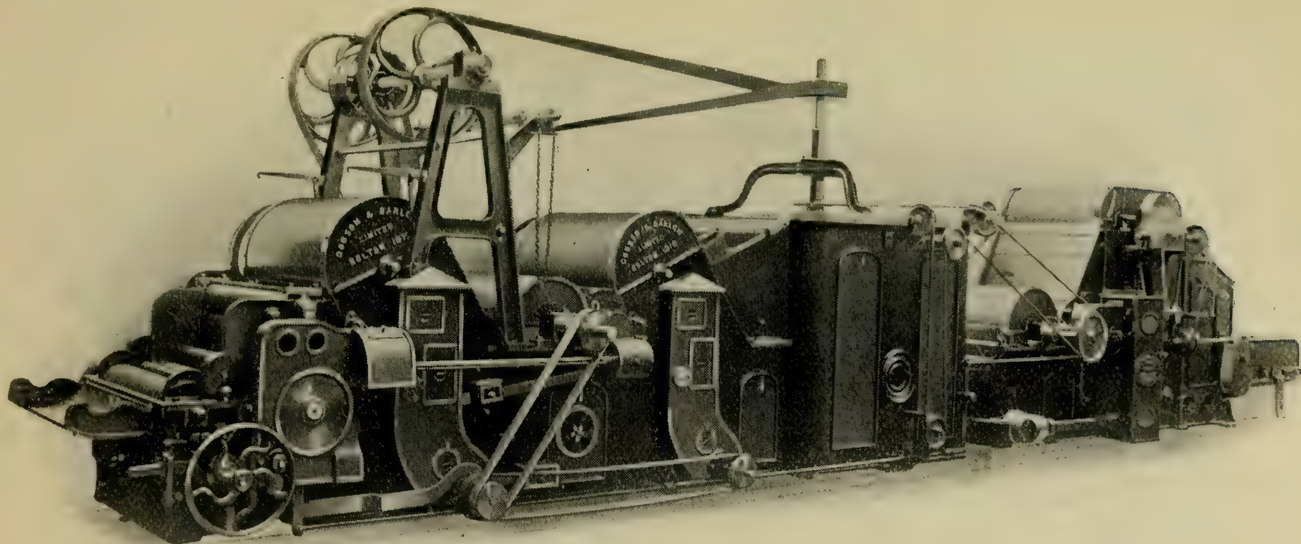
VIII.



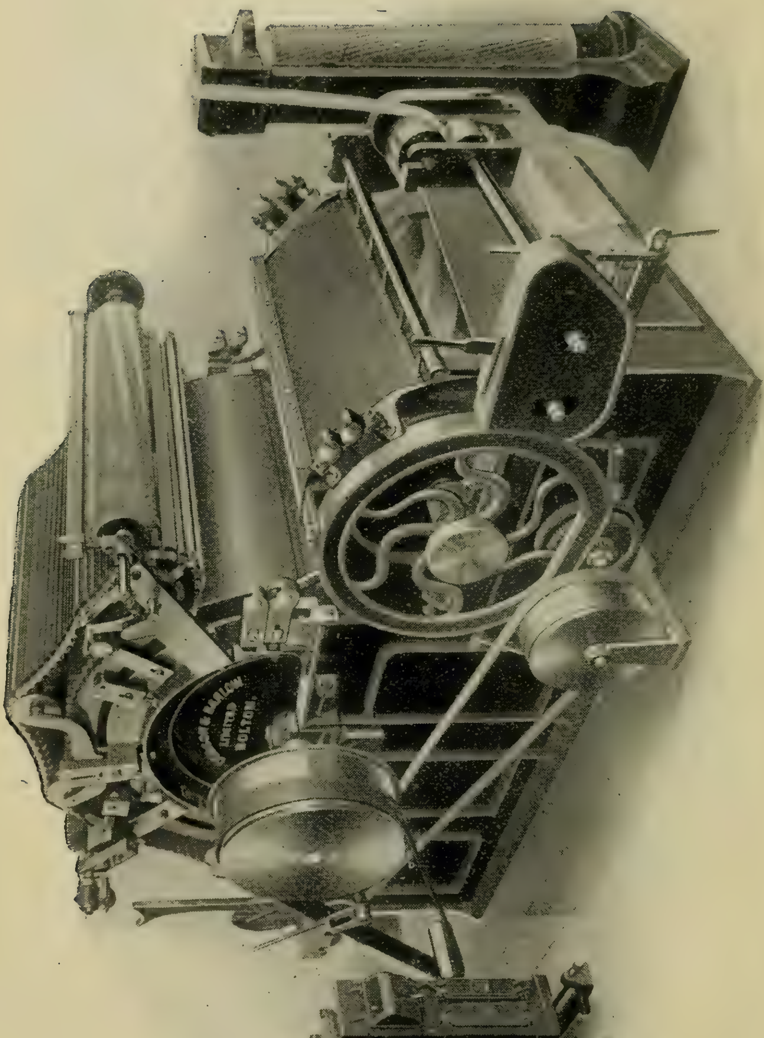
IMPROVED SINGLE-ACTION "MACARTHY" GIN.



Soft Waste Opener with 3 ft. of feed lattice, cylinder 24in. dia., licker-in $9\frac{3}{4}$in. dia., reversing motion to the feed roller and feed lattice.



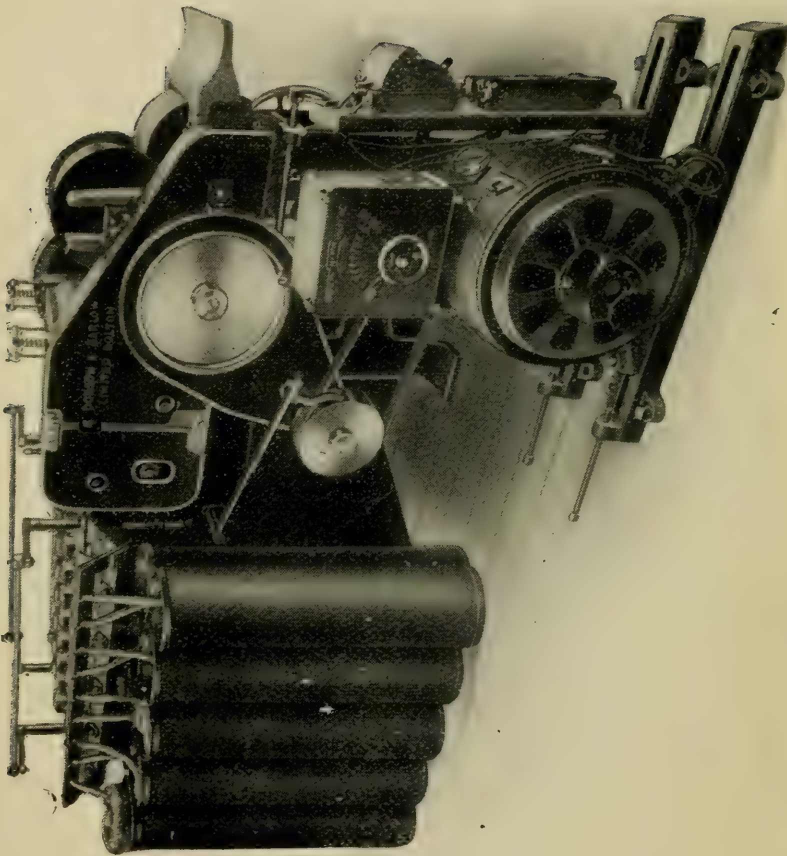
Vertical Beater Opener with Single Beater Scutcher and Lap Part, Hopper Feeder and Porcupine Opener, Counter Shaft fixed on machine.



XII.

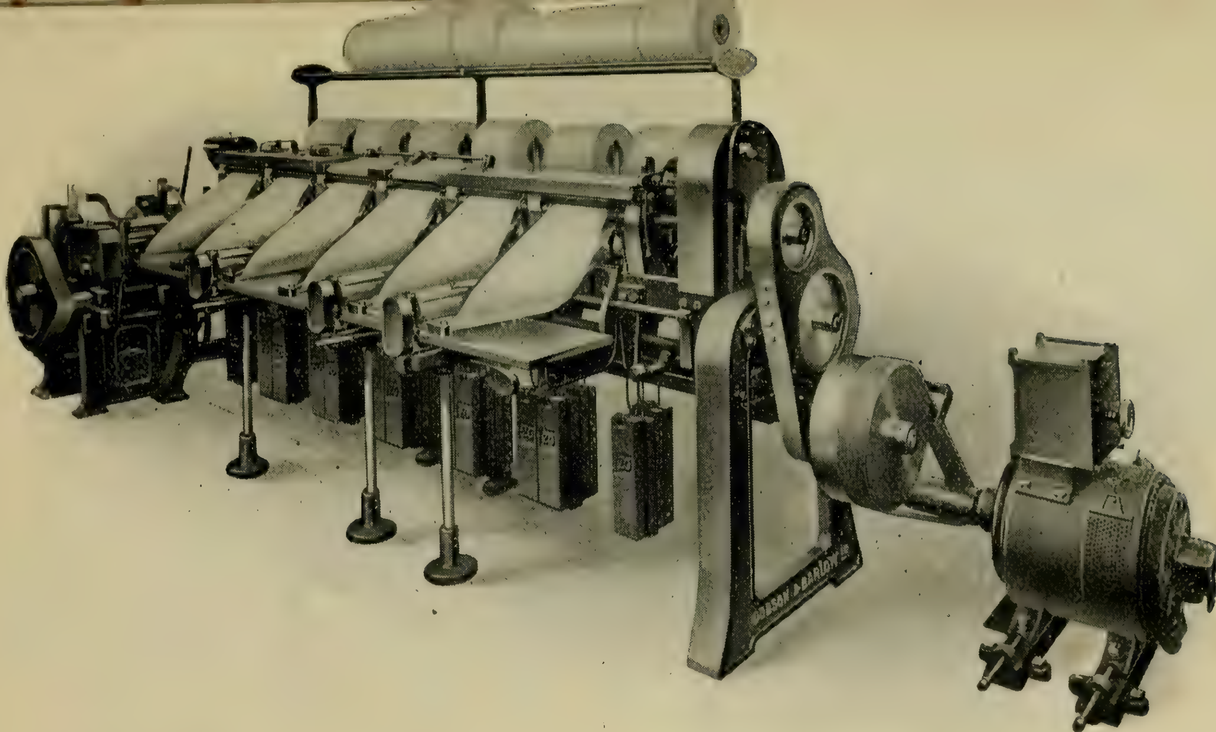
PATENT REVOLVING FLAT CARDING ENGINE,

38 in. wide on wire, with cylinder 50 in. dia., doffer 26 in. dia., licker-in 9½ in. dia. Improved flexible bend with five setting points. 109 flats, of which 44 are constantly at work, patent slipper for carrying the doffer is provided with a patent combined adjusting arrangement by which the whole of the adjacent parts are moved into position simultaneously, patent eccentric star wheel arrangement for driving the flats. This motion prevents tilting of the flats. Improved setting of the cylinder steps, anti-flexion flat grinding motion, slow motion to the flat stripping brush.

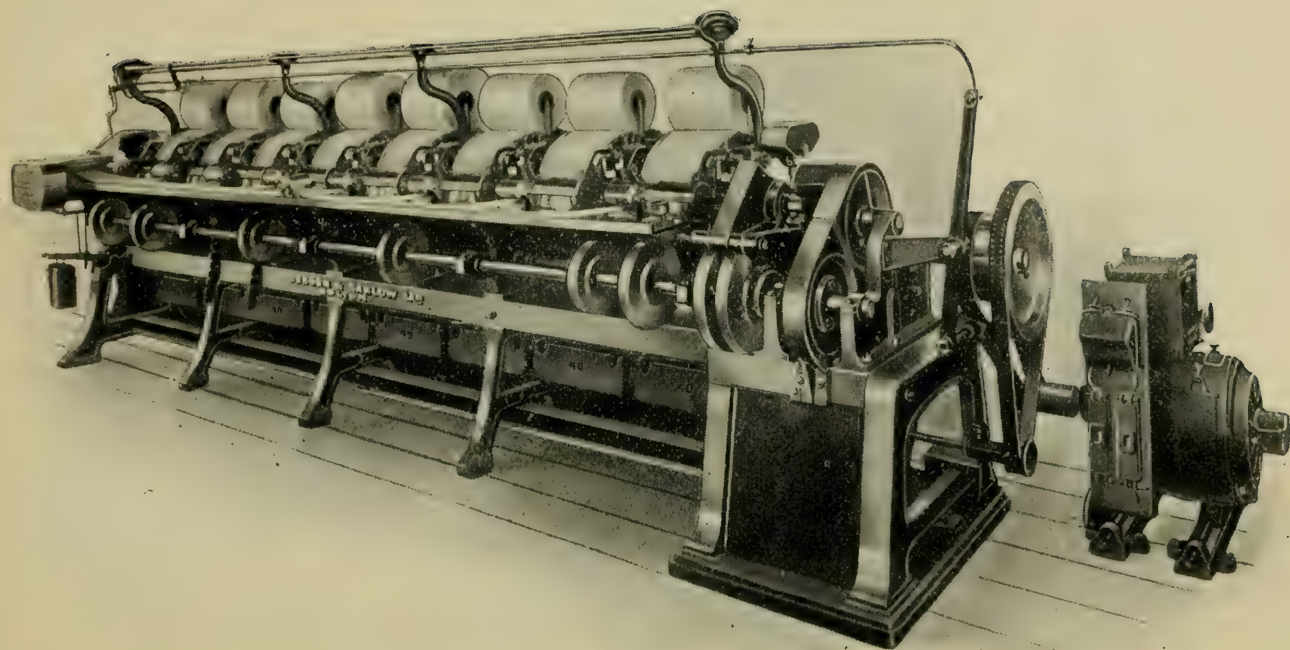


SLIVER LAP MACHINE,

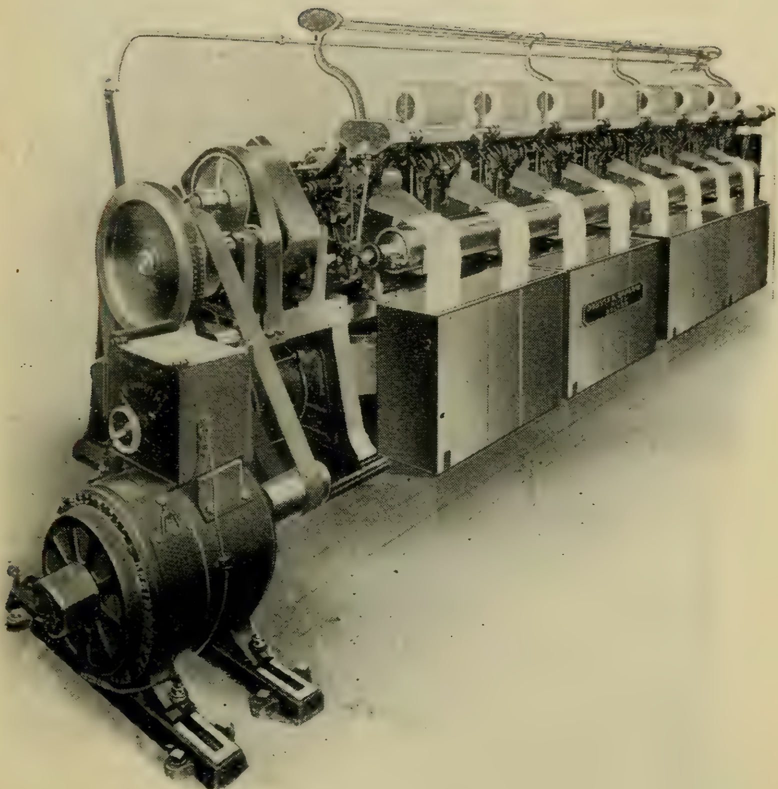
arranged to make a lap 9 in. wide, with V table,
18 cans at back.



Draw Frame and Lap Machine combined, with 6 heads, arranged to make a lap 10½in. wide, cast-iron flats to 2 heads, Dobson & Varley's clearers to 2 heads, "Ermen's" clearers to 2 heads, weight relieving motion to take the weight off the rollers when the machine is stopped.

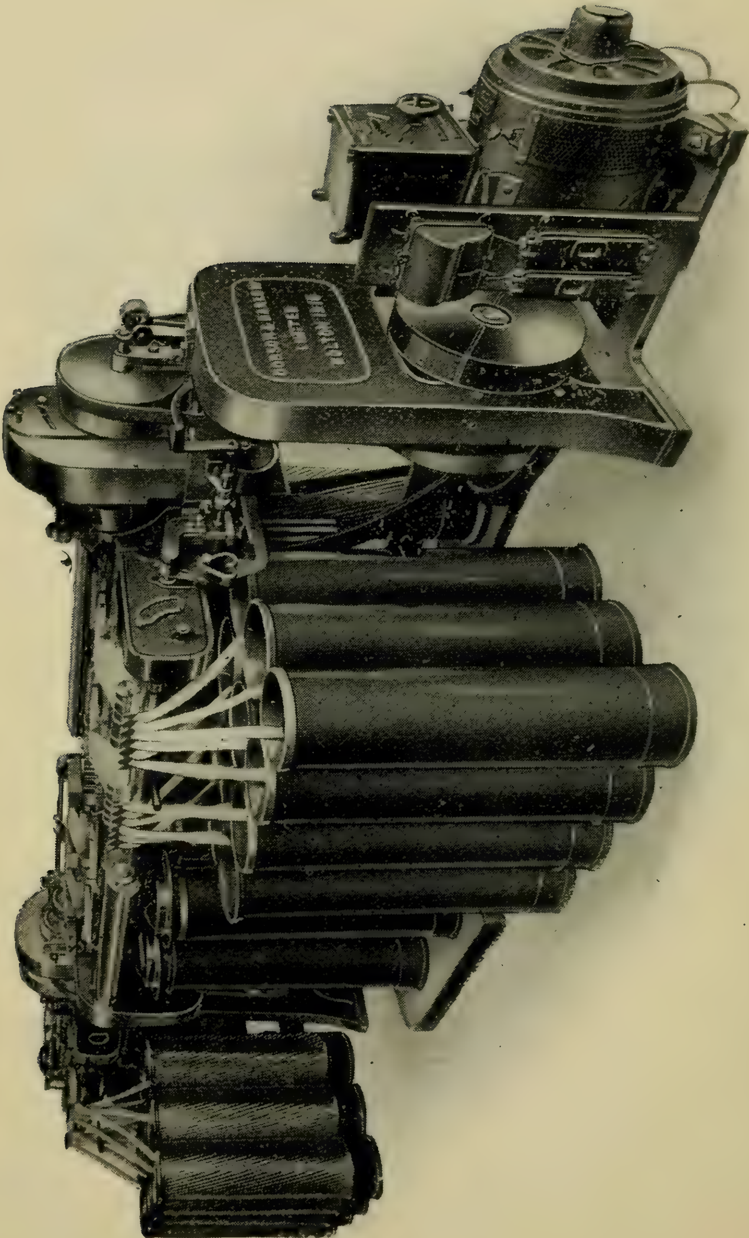


SINGLE NIP COMBING MACHINE with 8 heads, for lap 10½in. wide, stop motion when the cans are full, "Roth's" patent aspirator, "Birch's" patent detaching rollers.



SINGLE NIP COMBING MACHINE

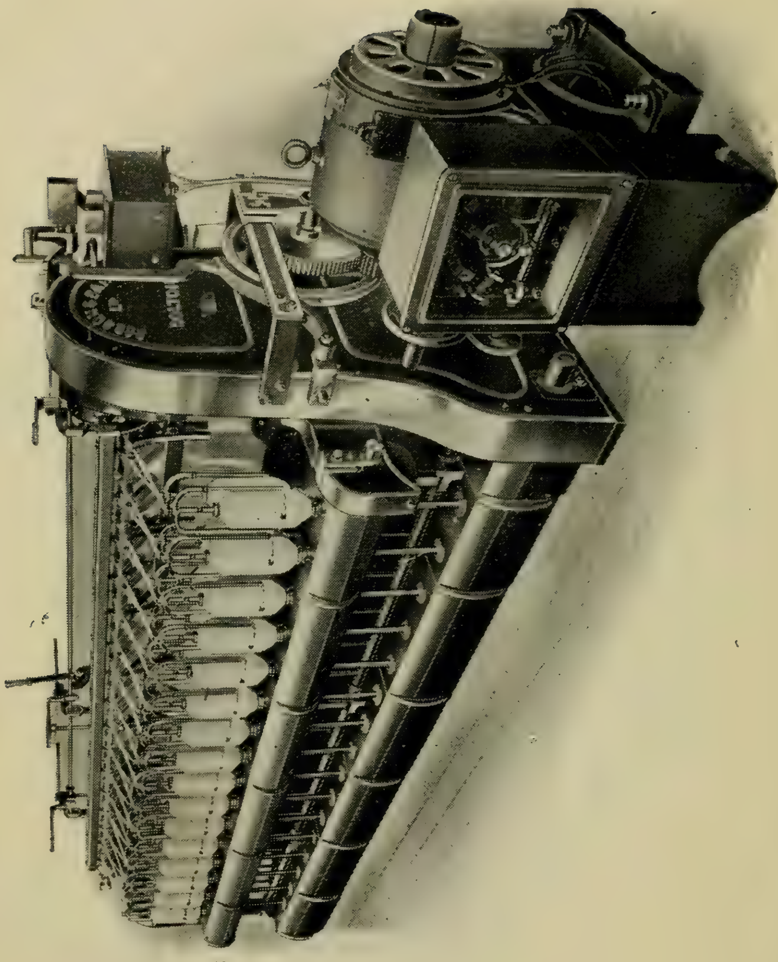
with 8 heads, for lap $10\frac{1}{2}$in. wide, stop motion when the cans are full, "Roth's" patent aspirator, "Birch's" patent detaching rollers.



XVIII.

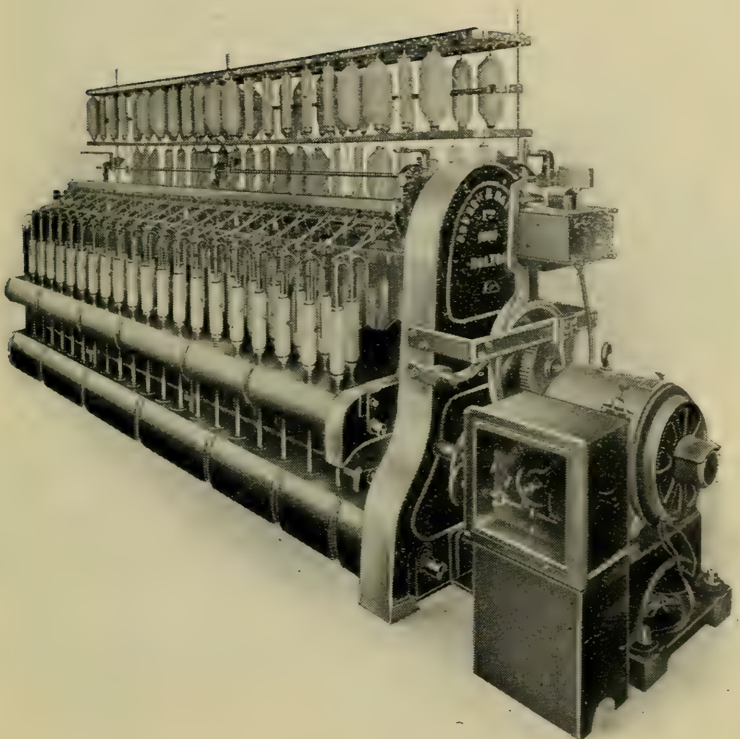
DRAWING FRAME

of 3 heads, with 2 deliveries per head, 6 slivers per delivery, improved back roller motion for preventing single, weight relieving motion, 2 heads with mechanical stop motion and 1 head with electrical stop motion, 1 head with Dobson & Varley's clearers, 1 head with "Ermen's" clearers, and 1 head with cast-iron flats for stationary cloth.



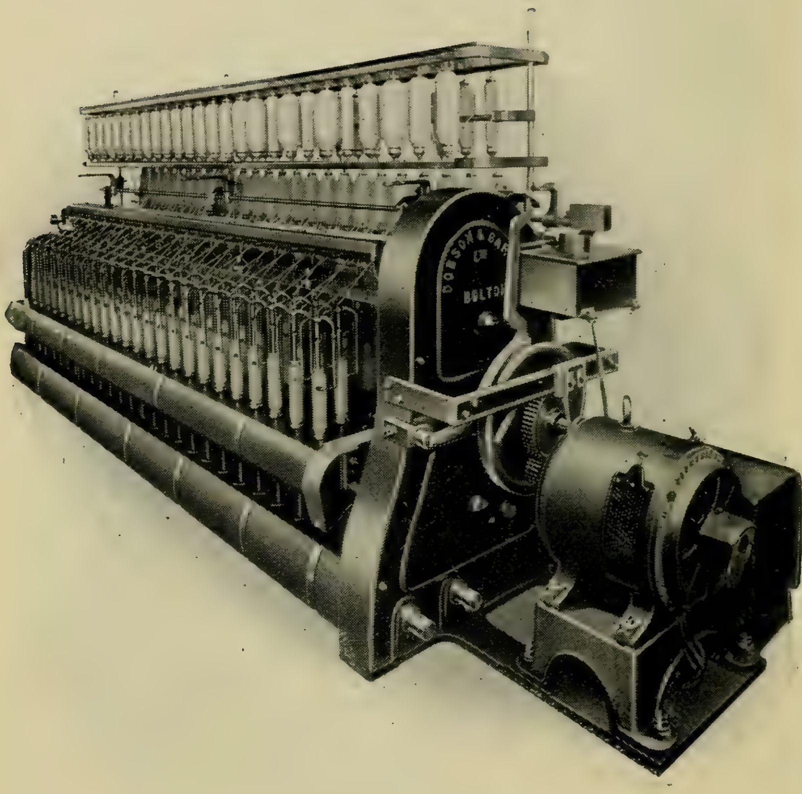
SLUBBING FRAME,

with 32 spindles, 10in. lift, long collars, patent differential motion, doors with automatic locking arrangement, patent arrangement for lubricating spindle footsteps, knocking-off motion when the bobbins are full.



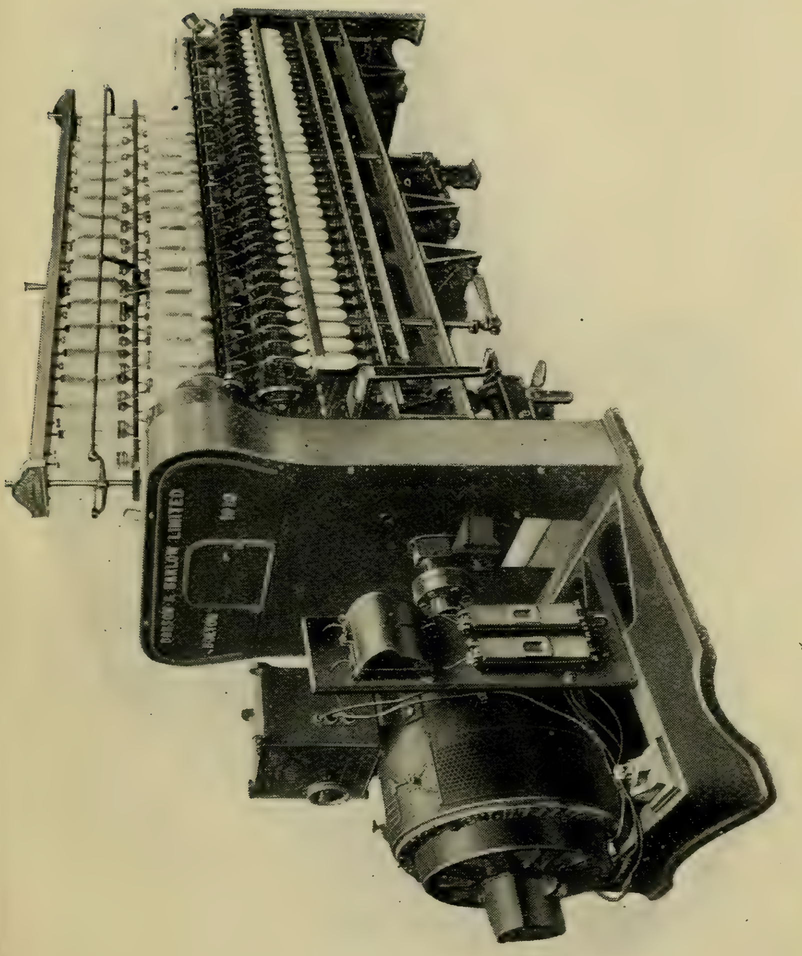
INTERMEDIATE FRAME,

with 40 spindles, 9in. lift, long collars, patent differential motion, doors with automatic locking arrangement, patent arrangement for lubricating spindle footsteps, knocking-off motion when the bobbins are full.



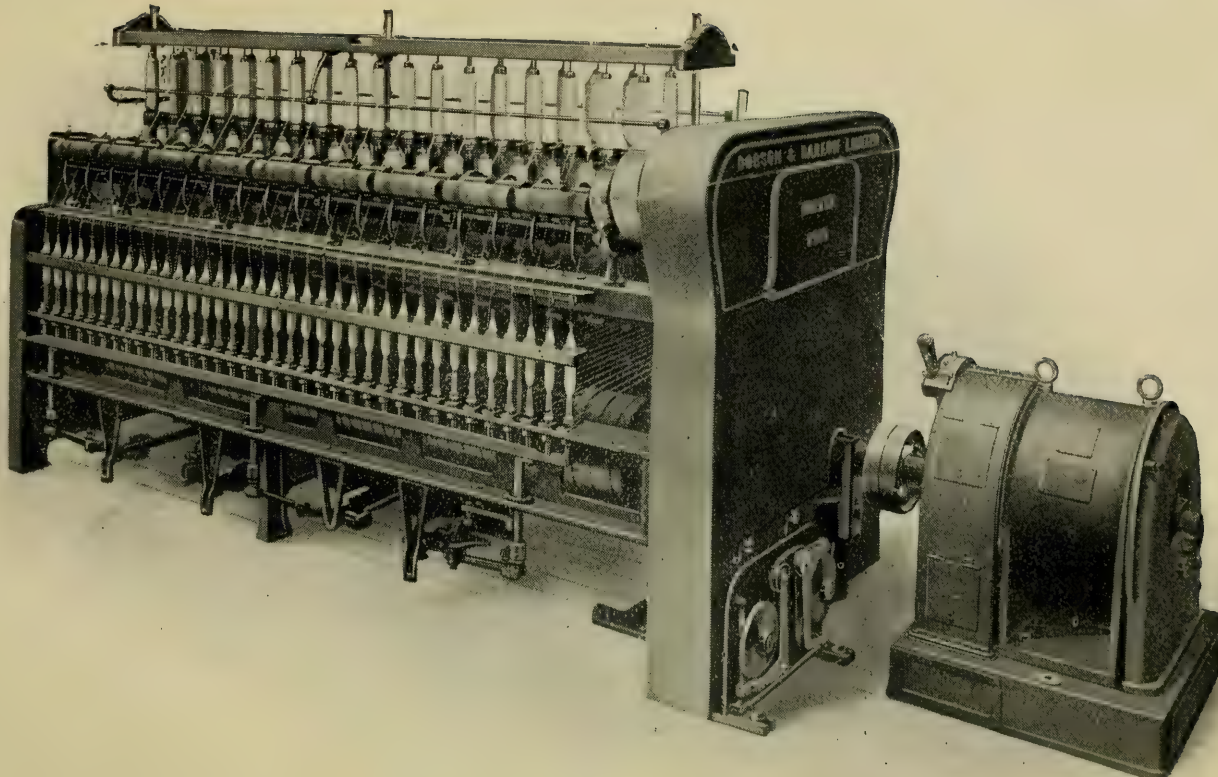
ROVING FRAME

of 48 spindles, 7in. lift, long collars, patent differential motion, doors with automatic locking arrangement, patent arrangement for lubricating spindle footsteps, knocking-off motion when the bobbins are full.

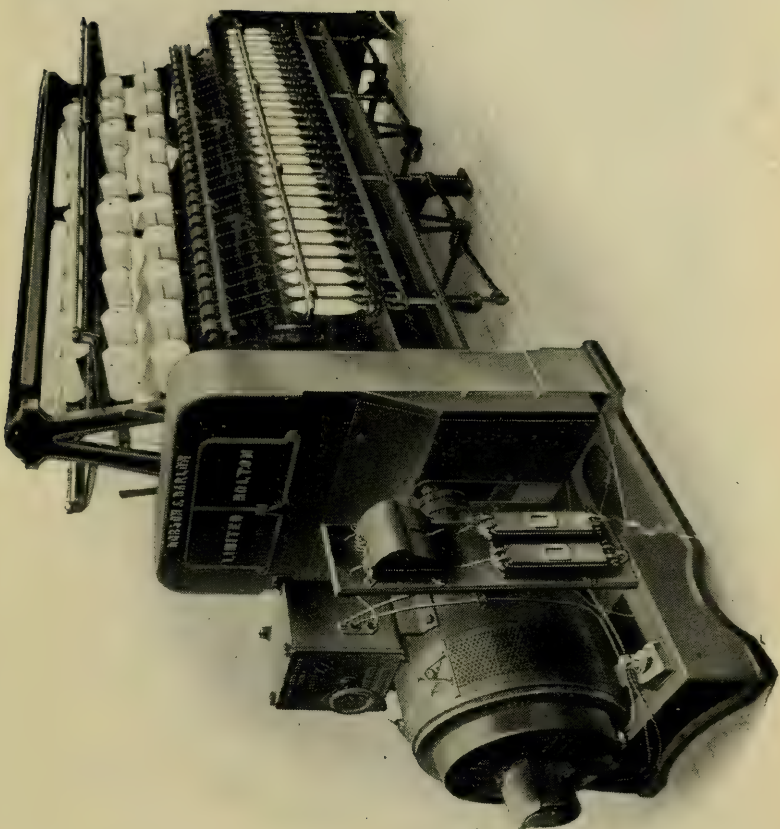


RING SPINNING FRAME

for twist of 64 spindles, $2\frac{1}{2}$ in. space, 7 in. paper tubes on one side and $6\frac{1}{2}$ in. wooden bobbins on the other side, patent "Simplex" flexible spindle, patent anti-ballooning plates on one side and separators on the other side, for spinning counts 20's and 30's, American cotton.

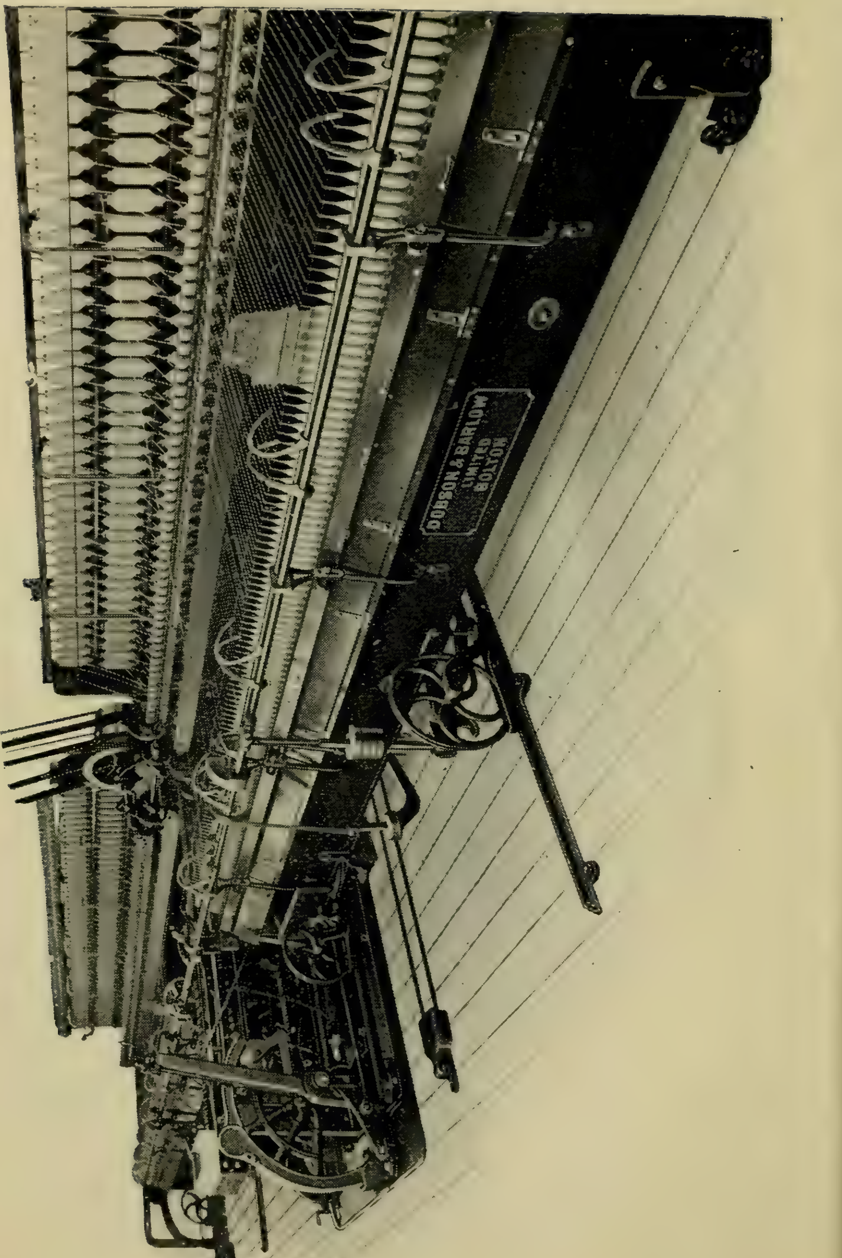


Ring Spinning Frame for weft, of 72 spindles, $2\frac{1}{4}$in. space, for spinning on paper tubes of 6in. lift, "Birkenhead" creel in two heights.



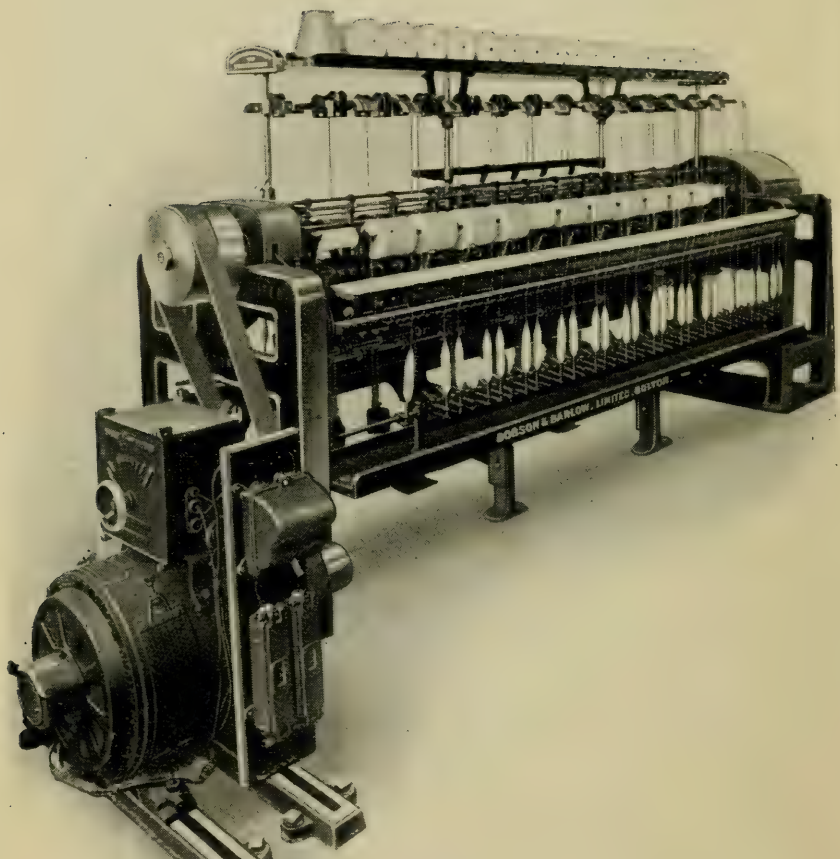
RING DOUBLING FRAME

of 56 spindles, 7in. lift, $2\frac{3}{4}$in. space, doubling rings on one side and spinning rings on the other side, 2in. dia., counts to be doubled 20's and 30's, two fold; patent flexible spindles with knee-brake; brass covered rollers and copper troughs with arrangements for lifting the glass cane out of the water.


DOBSON & BARLOW
LIMITED
BOLTON

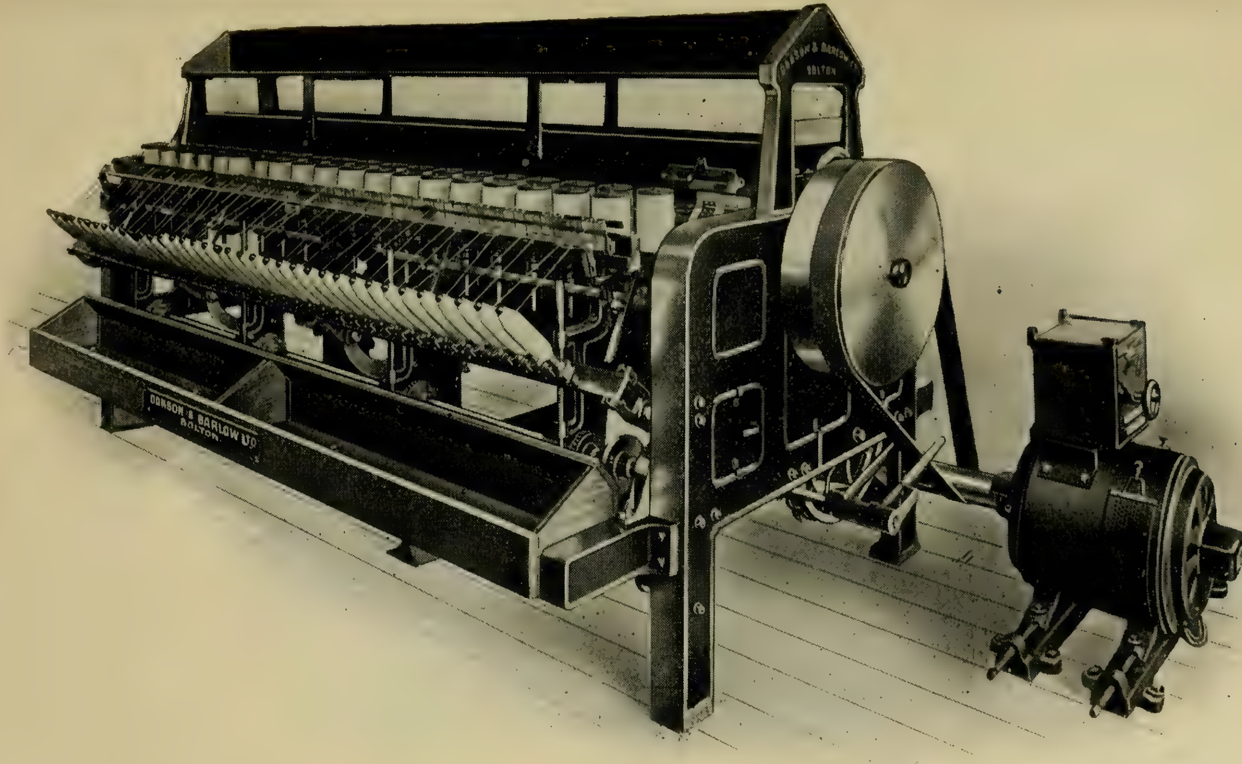
SELF-ACTING MULE,

64 in. stretch, $1\frac{1}{4}$ in. space, with 332 spindles, for spinning counts 20's to 30's, American cotton; creels for single roving, governor motion, patent automatic nosing motion, patent automatic "Express" backing-off motion, duplex drive travelling scavenger.

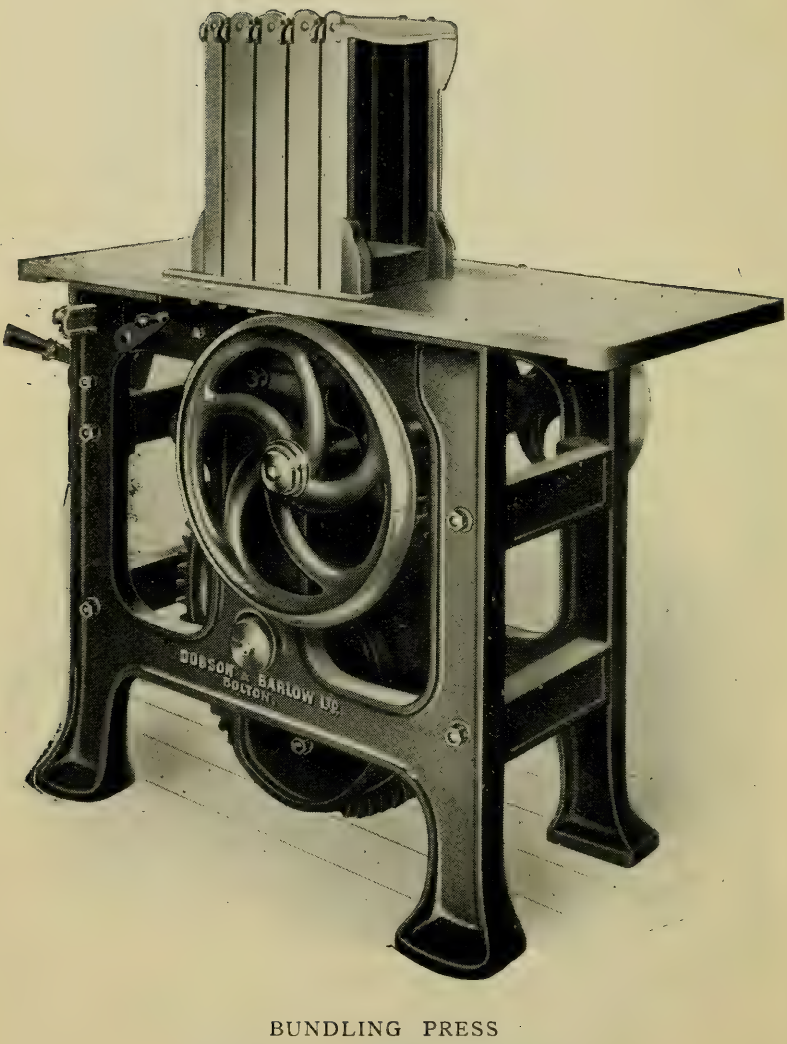


CROSS WINDING FRAME

with 26 drums, 5 in. traverse, stop motion to each drum.



VERTICAL SPINDLE WINDING FRAME with 76 spindles, 5 in. space.



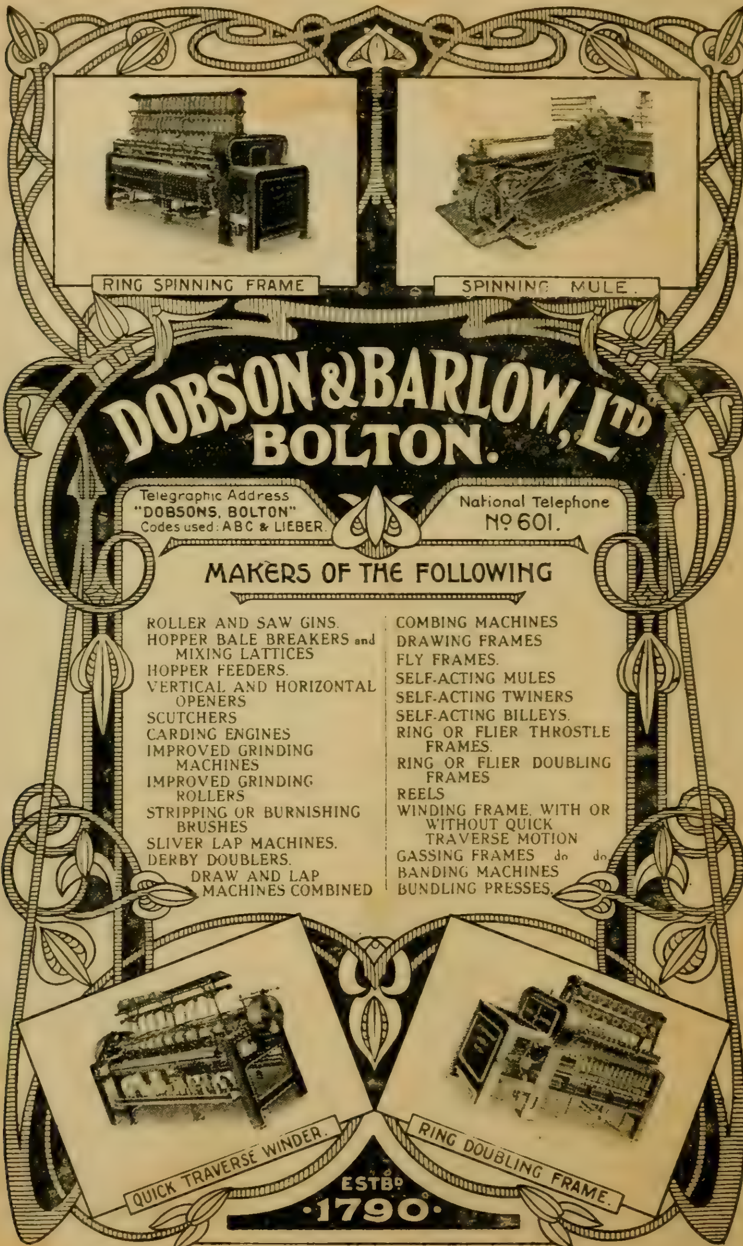
BUNDLING PRESS
for making bundles of 10 lbs.

SECTION I:

RAW COTTONS

THE LIVERPOOL MARKET

WORLD'S
SPINDLES AND CONSUMPTION


RING SPINNING FRAME
SPINNING MULE.
DOBSON & BARLOW, LTD
BOLTON.
Telegraphic Address
"DOBSONS, BOLTON"
Codes used: ABC & LIEBER.
National Telephone
No 601.
MAKERS OF THE FOLLOWING
ROLLER AND SAW GINS.
HOPPER BALE BREAKERS and MIXING LATTICES
HOPPER FEEDERS.
VERTICAL AND HORIZONTAL OPENERS
SCUTCHERS
CARDING ENGINES
IMPROVED GRINDING MACHINES
IMPROVED GRINDING ROLLERS
STRIPPING OR BURNISHING BRUSHES
SLIVER LAP MACHINES.
DERBY DOUBLERS.
DRAW AND LAP MACHINES COMBINED
COMBING MACHINES
DRAWING FRAMES
FLY FRAMES.
SELF-ACTING MULES
SELF-ACTING TWINERS
SELF-ACTING BILLEYS.
RING OR FLIER THROSTLE FRAMES.
RING OR FLIER DOUBLING FRAMES
REELS
WINDING FRAME, WITH OR WITHOUT QUICK TRAVERSE MOTION
GASSING FRAMES do do
BANDING MACHINES
BUNDLING PRESSES.
QUICK TRAVERSE WINDER.
RING DOUBLING FRAME.
ESTBD
·1790·

THE LEADING GROWTHS OF COTTON

Those that have to purchase the raw material of the cotton manufacture, to arrange the "mixings," or in any other capacity have much to do with the raw material, should know as much as possible of its characteristics; for ignorance in regard thereto may cause much trouble and no little loss to those who have to spin the cotton. Each crop differs from the previous one to a greater or lesser degree, as it depends entirely upon the weather, which in the cotton-growing areas of the world, as elsewhere, is variable.

Thus in a very dry season there is what is termed a "droughty crop," which, whilst it may be (and mostly is) clean and well up in class, will yet be poor in staple; and in order to obtain the desired length and strength of staple, the buyer will have to pay a relatively higher price than in what may be termed a normal season.

Again, in a crop that is poor in class—a defect that may have been caused by too much rain in the early or middle stages of its growth, or by unfavourable weather for the production of cotton of good grade—the staple will probably be all that could be desired, but the buyer will have to pay more to obtain his usual grade, and especially so if he requires it for good weft.

Then there are seasons when the crop turns out fairly good in class and staple, but the cotton is wasty, dirty, or abnormally leafy; and in this case the buyer has to exercise great care and judgment in calculating the extra loss that will ensue.

The above remarks refer particularly to American cotton, but they are applicable to other growths.

The reader may be considerably helped by studying the following concise statement of leading facts relating to cotton in its principal varieties :—

THE WORLD'S COTTON SUPPLY.

It is estimated that there are some 145 million cotton spinning spindles in the world, and that when in full work these consume annually about 22 million bales of cotton.

Of the world's spindles, Great Britain possesses about 40 per cent., other European countries 30 per cent., India and Japan 6 per cent., the United States 21 per cent., and other countries 3 per cent. Of the annual consumption.

A LIST OF COTTONS:

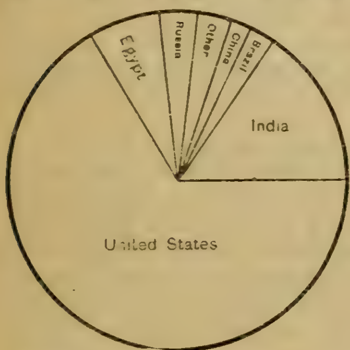
Their length, colour, and the counts for which they are suitable.

	Variety	Average length	Relative price ‡	Colour	Counts up to	Remarks
		inch				
Sea Islands		$1\frac{3}{4}$	230	Cream	200	Very silky and regular
Egyptian	Joanovich	$1\frac{1}{2}$	140	Dark cream	150	Silky
	Sakellaridis	$1\frac{1}{2}$	145	Dark cream	150	Silky and soft
	Nubari	$1\frac{3}{8}$	130	Light brown	100	Silky, but rather irregular and weak
	Abassi	$1\frac{3}{8}$	132	White	100	Now little grown
	Brown	$1\frac{3}{8}$	125	Deep brown	100	Very regular
	Upper	$1\frac{1}{8}$	115	Muddy brown	60	Weak and dirty
Brazilian	Pernams, etc.	$1\frac{1}{8}$	105	Dull white	60	Harsh
	Ceara, etc.	1	103	Dull white	60	Harsh
Peruvian	Rough	$1\frac{1}{4}$	117	Cream	For mixing with wool	Harsh and wiry
	Mod. Rough	$1\frac{1}{4}$	109	Cream		Harsh
	Smooth	$1\frac{1}{8}$	113	White	60	Soft, similar to American
	Sea Islands	$1\frac{3}{8}$	132	Variable	100	Silky, but irregular
American	Orleans	$1\frac{1}{8}$	105	White	60	Clean, soft, and strong
	Texas	1	100	White	50	Clean and strong
	Uplands	1	100	White	50	Softest of Americans
	Mobile	$\frac{7}{8}$	95	White	50	Dirtier and weaker than other Americans
Indian	Surtee, Broach, etc.	$\frac{7}{8}$	80	Light brown	20	Clean and strong
	Scinde	$\frac{5}{8}$	55	Dull white	10	Poor and dirty
	Bengal	$\frac{3}{4}$	55	Light brown	10	Dirty and harsh
	Tinnivelly	$\frac{7}{8}$	82	White	20	Best of Indians
	Madras, Western	$\frac{3}{4}$	71	Light brown	20	Fair class
China		$\frac{3}{4}$	85	Dull white	20	Clean, rather harsh
Smyrna		$\frac{7}{8}$	85	Dull white	20	Rather harsh
West African		1	90	White	50	Similar to American

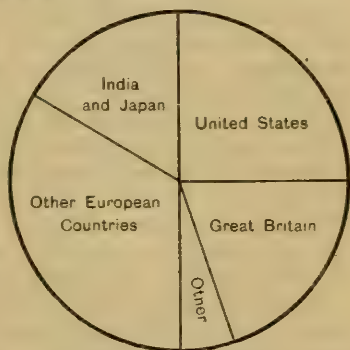
‡ Approximate price on the basis of Middling American = 100.

Great Britain uses about 20 per cent., other European countries 34 per cent., India and Japan 16 per cent., the United States 25 per cent., and other countries 5 per cent. It will be noticed that Great Britain has the smallest consumption in relation to spindles, and that India and Japan have the largest. This is accounted for by the great difference in the average counts of yarn produced: Great Britain spins her cotton into yarns of comparatively fine counts, which means that the consumption per spindle is small, while India and Japan produce yarns of coarse counts, with a large consumption per spindle.

Cotton being the product of a tropical or semi-tropical plant, the area of its cultivation is limited by climatic



WORLD'S COTTON CROPS.



WORLD'S CONSUMPTION OF COTTON.

conditions; and all the actual and potential cotton-growing lands are within a belt of the earth's surface extending from about 40° North to about 30° South of the Equator. At present the cotton supplies of the world are produced by the following countries, which grow annually (in round figures):—United States of America, 14,000,000 bales; India, 4,500,000 bales; Egypt, 1,000,000; Russia, 800,000; China, 400,000; Brazil, 400,000; other countries, 900,000—making a total of 22,000,000 bales.

Making allowance for the different weights of bales in the various countries, this gives the following (percentages):—United States, 65 per cent.; India, 16; Egypt, 7; Russia, 4; China, 2; Brazil, 2; other countries, 4.

THE UNITED STATES.—This crop last year exceeded 14,000,000 bales of 500 lb. each, and in the record year 1911-12 a crop of over 16,000,000 bales was produced. American cotton is the raw material for the great bulk

of the world's common domestic goods. It is grown principally in the States lying to the south-east, by far the largest producer of which is Texas, within whose borders about a quarter of the whole crop is grown. The other cotton-growing States are—Louisiana, Mississippi, Alabama, Florida, Georgia, North Carolina, South Carolina, Virginia, Tennessee, and Arkansas. While in general characteristics most American cottons are very similar, there are four well-defined commercial varieties—Orleans, Texas, Uplands, and Mobile.

Orleans.—This cotton (so called because it is mostly shipped from the port of New Orleans) is the best variety. It is the most regular and of the longest staple, having a fibre of about $1\frac{1}{8}$ inch; it is fairly strong, elastic, and of a white to light creamy colour. It is grown largely in the States of Mississippi and Louisiana, and is often referred to as "Gulf" cotton, from the proximity of these States to the Gulf of Mexico.

To this variety belong also the long-stapled American cottons known as "Benders," "Peelers," "Allen Seed," or collectively as "Extras" or "Stapled Americans." These cottons are grown on some of the most fertile lands in the Mississippi district, and have a staple of $1\frac{1}{8}$ inch to $1\frac{1}{2}$ inch. There is to-day an important demand for the "Stapled American" cottons for mixing with Egyptian, and for the making of yarns to compete with the better-class Egyptian yarns.

Texas.—Texas cotton is similar generally to Orleans, but is of a slightly deeper colour, and is rather shorter in staple, averaging about 1 inch in length. It is rather above the average of American cottons in strength, which makes it especially suitable for twist yarns.

Uplands.—This cotton derives its name from the fact that it is grown on the "Uplands" of Georgia, South Carolina, and Alabama. It is a soft clean cotton, of about 1 inch in length, but has not the strength of Orleans or Texas, and is consequently best suited for weft yarns.

Mobile.—"Mobile" cotton (so called from Mobile, the port of shipment) is similar generally to Uplands, but is neither so clean nor so strong in fibre. It is the poorest of American cottons, and (like Uplands) is best suited for weft yarns. Average length, about $\frac{7}{8}$ inch.

Sea Islands.—Included in the figures of the American crop—though *not* included in the commercial term

"American cotton"—is the long-stapled "Sea Islands" cotton. This is grown in the States of Florida, Georgia, and South Carolina, and on the islands off their coasts—James and John Islands, Edisto, St. Helena, St. Simon, and Cumberland Islands, and others. It is of the famous Gossypium Barbadense or "Black Seed" variety, and is the finest cotton grown, having a staple of 1½ inch to 2 inches in length, fine in diameter, and regular in natural twist and length. It is clean, strong, and elastic, and has a silkiness possessed by no other cotton. The crop is not a large one, varying from about 60,000 to 100,000 bales per annum, by far the largest part of which is grown in the State of Florida.

INDIA.—Though the Indian crop is a large one, only a small proportion of it is imported into England, the bulk being used in India, Japan, and on the Continent of Europe, in all of which places the counts spun are much coarser than in England. Indian cottons generally are of a low class, which is due partly to the primitive methods of cotton culture still practised in many parts, and partly to the climatic conditions of the country, which, with an insufficient rainfall, allow only a short period of growth. There are indications, however, that before long an improvement will be effected in the quality of Indian cottons, and an increase in the quantity grown. Much attention has recently been given to the matter, both by the Indian Government and by the British Cotton-Growing Association. Better methods of cotton culture, the selection of seed, irrigation works, and experimental farms—all these are bringing about changes in certain districts; and as a result much cotton of a quality equal to Middling American is now being grown in India. The great bulk of Indian cotton, however, is still very short in staple, ranging from ½ to 1 inch in length. The fibre is coarse, and the cotton contains a large amount of dirt and dust.

Hinganghat.—"Hinganghat" or "Bani" cotton forms an exception in respect of the foregoing remarks. It is probably the finest class of cotton grown in India, having a staple of fully 1 inch in length, and being fine and somewhat silky. This particular variety is rarely exported, being used mostly by Indian spinners for their better-class yarns.

INDIAN COTTONS ON LIVERPOOL MARKET.

The Indian cottons of the Liverpool market are divided into three groups: Surats, Bengal, and Madras.

Surats.—Surat is a small port in the Bombay Presidency, from which a large quantity of this cotton was formerly exported. The cottons of the Surat group constitute by far the largest portion of the Indian crop. They are :—

SURTEE, the best;
BROACH;
DHOLLERA;
DHARWAR, an acclimatised Orleans cotton;
BHOWNUGGAR;
OOMRA or OOMRAWUTTEE;
KHANDEISH, a short, harsh, and brittle cotton;
COMPTAH;
BAGALKOTE; and
SCINDE, the poorest and dirtiest.

Bengal.—Bengal cottons are short and dirty, and of a quality similar to Scinde. They average about ⅝ inch in length, and are only suitable for the coarsest counts.

Madras.—The Madras cottons are: Tinnevelly, Westerns, Northerns, and Coconada.

TINNEVELLY is the best, and is one of the few Indian cottons which may be suitably mixed with American. It is very white in colour, clean, and strong. A fair quantity is imported into England.

WESTERNS is a poorer variety than Tinnevelly, being dull and harsh and not so clean, but it has a fairly long staple.

NORTHERNS is a better cotton than Westerns, being softer and silkier, though not so white.

COCONADA (or RED COCONADA, as it is sometimes called) is a highly coloured cotton, with a moderate staple.

CAMBODIA (or "TINNEVELLY AMERICAN") is a new Madras cotton, which is very similar to Uplands American, with a fine strong fibre of about 1 inch in length. This cotton has so far been a great success, and has probably a future before it.

Burma.—A crop of from 30,000 to 40,000 bales of cotton is grown in Burma. This cotton is mostly short-stapled (about ½ inch to ¾ inch in length), though there is also a fairly long and silky cotton of the perennial tree-cotton type, which is grown in small quantity.

EGYPT.—The Egyptian crop is reckoned in "*cantars*," a cantar being equal to 98 lb. During recent years the crop has varied between 5½ and 7 million cantars. The Egyptian bale contains about 7 cantars, or 700 lb. This gives a crop of from 700,000 to 1,000,000 bales. Egypt, being practically a rainless country, is dependent on the

River Nile for its water-supply. The river annually overflows its banks, and deposits a rich layer of silt and mud over the cotton-growing lands. Within recent years a vast amount of money has been spent on perfecting an irrigation system, by which a continuous supply of water is available all the year round. This has made it possible to extend the country's cotton-growing area very largely.

Egyptian cotton ranks next to Sea Islands in point of quality, and is used for the world's finer cotton goods. The largest user is England, which has more spindles working up Egyptian cotton than all the rest of the world together. The commercial varieties are Mitafifi, Abassi, Joanovich, Ashmouni, Nubari, Sakellaridis, and Assil. Of these, Mitafifi is the most important, constituting about 40 per cent. of the crop.

Mitafifi.—Mitafifi (or "Brown Egyptian," as it is called in the cotton-using countries) is the average quality of Egyptian cotton, having a staple of about 1⅜ inch in length, and is noted for its regularity both of length and colour. It derives its name from a village in the province of Galuibia, where it was first grown about thirty years ago. It is now cultivated extensively in Lower Egypt and the Nile Delta.

Abassi.—This is the whitest of the Egyptian cottons, and has been grown since about 1890 in the Delta of the Nile. It has a long fine fibre, but has not quite the length of the Brown variety. It seemed a few years ago as if Abassi were about to disappear, but recently the cultivation of it has slightly increased.

Joanovich.—This is one of the best of Egyptian cottons. It was first grown in 1897, and was produced by artificial selection from the Brown variety Mitafifi. It is fine, strong, clean, silky, and has a staple of about 1½ inch in length. It is the cotton that most nearly approaches Sea Islands in its general characteristics, though it is a little darker in colour and is not so silky. It will spin yarns up to 150's counts.

Ashmouni.—Ashmouni (or "Upper Egyptian") is one of the older cottons of Egypt, and is the poorest in quality, being weaker, more irregular, and dirtier, than the other varieties. It has a staple of about 1⅛ inch, and is used mostly for the coarser wefts. Recently complaints have been made regarding the mixing of this cotton with Mitafifi, which reduces the quality of the Mitafifi, and produces a deteriorated seed for sowing purposes.

Nubari.—This is a cotton of recent growth. It is somewhat similar to Joanovich, but is rather darker, weaker, and more irregular.

Sakellaridis.—Sakellaridis is a new variety of long-stapled cotton, similar to Joanovich. It came into prominence about three years ago, and is closely rivalling Joanovich, to which it is in some respects superior. It possesses many of the characteristics of Sea Islands, and is also a very productive cotton, giving a greater yield than most of the other varieties.

Assil.—Assil (or Assil Afifi) is another recent variety, or rather it is an endeavour to recover an old variety that is disappearing. The word *Assil* is Arabic, meaning "thoroughbred," and the Assil Afifi is pure Afifi cotton. It is very strong and regular; and although up to the present there has not been a large quantity grown, it will probably be increased, and should prove a very useful cotton to the users of Brown Egyptian.

RUSSIA.—Practically the whole of the cotton grown in the Russian Empire is used by Russian spinners. There are two sources of supply—Turkestan and the Caucasus. Cotton has been grown in **Turkestan** from the earliest times for native use, and the indigenous variety has a rough short staple of about $\frac{7}{8}$ inch in length. A peculiar feature about this native cotton is that the pods do not open, as in the case of American cotton, and the fibre is obtainable only by breaking off the whole boll. The greater quantity of Russian cotton, however, is now grown from American seed of the Upland variety. The American Civil War of the 'sixties, with the resultant cotton famine, caused a great impetus to experiments with new cottons in all parts of the world. In Asiatic Russia the better yield and superior quality of cotton grown from American seed led to a great expansion in cotton-growing, and to-day the native variety is only grown in those parts where the American cotton is not so successful.

In the **Caucasus** the cotton-growing conditions are very similar to those of Turkestan; and though the crop is not so large, a great development is taking place. Here also are two varieties—the native cotton (similar to that of Turkestan) and the American variety. In both these parts of the Russian Empire there is abundant cotton land, but the climatic conditions are such that artificial irrigation is necessary. This work is being gradually

developed, and we may look forward to a steady increase in the quantity of Russian cotton. The cultivation, however, is very expensive, and the landowners can succeed only if credit is extended to them by cotton firms. These firms usually advance money for that purpose in the spring, under security of the future crop. Last season's (1913) market, however, brought considerable losses, which, with the general economic crisis in Turkestan, forced the cotton firms to curtail the spring loans in 1914.

Mr. J. H. Snodgrass, the United States Consul-General at Moscow, writing in August, 1914, stated that 40 to 45 per cent. of the money advanced in 1913, amounting to £1,050,000 to £1,250,000, had not then been returned. The cotton firms this year extended the time of payment of the old debts, and added only 10 to 20 per cent. of new credits, which were conservatively granted late in the season. Cotton planters, however, came out this season better than was expected, on account of the abundance of cattle and feed and the high cotton prices of last year, which made money more plentiful than usual.

The following figures for the cotton acreage of Russia are taken from a Moscow commercial journal ("Industry and Trade") for June 28th, 1914. The area planted with cotton in 1914 is given as 1,979,000 acres, an increase of about 5 per cent. over 1913. The acreage is distributed as follows:—Transcaspia, 114,600 acres; Bokhara Territory and Tchardjuy and Kerkin districts, 158,610 acres; Samarkand Territory and the Kattakurgan district, 90,040 acres; Tashkend and Syr-Daria Territories, 121,490 acres; Ferghana Territory, 1,048,840 acres; Khiva Territory, 126,210 acres. The latest exact figures for the cotton acreage of Transcaucasia relate to 1912, when there were 303,850 acres; for 1914 the area under cotton is estimated at 319,110 acres.

CHINA.—It is very difficult to say how much cotton is grown in China, as there are few available statistics. While some authorities have estimated the crop as equal in quantity to the Egyptian, it is probable that a truer estimate is about 400,000 bales per annum. Much of the cotton is used in the native domestic industry, and so never passes through any organised cotton market. It is a clean, white cotton, with a rough, short staple of about ¾ inch, and is suitable for about 10's to 12's yarn. There are small quantities constantly passing through

the Liverpool market; and in times of high-priced American, quite an appreciable amount of Chinese is used in this country.

BRAZIL.—Brazilian cotton is similar generally to American, but is harsher and dirtier. Though it is classed under different names (according to the ports of shipment), there is a general resemblance between the different varieties. The better-known growths are: Pernam, Parahyba, Maceio, Ceara, Maranham, and Mossoro. Of these, Pernam is the best. A fairly large quantity of Brazilian cotton is used in England. Brazil possesses a very large area of suitable cotton-growing land; and with better methods of picking and handling, and more transport facilities from the interior, the country should in the next few years greatly increase its cotton crop.

The Third Secretary to H.M. Legation at Rio de Janeiro lately forwarded to the Foreign Office the following interesting information regarding cotton-growing in Brazil:—The exports of cotton in 1913 shewed a marked increase over those of the previous year, having risen from 16,773,942 kilos. to 37,423,616 kilos., four-fifths of which were exported to the United Kingdom. There has been a slight fall in the value of Brazilian cotton since 1910, but prices during the last two years have kept to the same level, *i.e.*, 928 reis per kilo. (about 6¾d. per lb.). The growing importance of the cotton industry in Brazil has attracted capital from other less remunerative enterprises; the Jequié Rubber Co., for instance, has forsaken rubber for cotton, "because it ensures better results, and can compensate for the heavy losses which might attend the cultivation of rubber." The system of cultivation is still very backward, but the Ministry of Agriculture has been endeavouring of late to introduce more practical methods of cultivation, and is setting up an experimental station for the intensive cultivation of cotton in the State of Maranhao.

TURKEY.—In Asiatic Turkey a fair quantity of cotton is grown. The crop varies considerably in bulk from year to year, but averages about 100,000 bales. About one-half is grown in the district around Smyrna, and the remainder in that around Adana.

This Levantine cotton is harsh and short, and is only suitable for very coarse yarns. As in Asiatic Russia, so also here the cotton is not picked in the fields, but the

bolls are cut off, the cotton itself being afterwards picked out by the growers in their homes. This probably accounts for much of the broken leaf and dirt found in the cotton.

Two kinds are cultivated: (1) the native variety, called "Yerli," which is the rougher and shorter; and (2) the American variety, which has a fibre rather longer and softer. Though the native variety does not produce so satisfactory a fibre as the American, it is better able to stand the drought, and accordingly is regarded as the safer crop to grow.

PERU.—Peru produces about 100,000 bales of cotton per annum. There are three varieties grown, very different from each other in their general characteristics:—

(1) **Peruvian Sea Islands.**—This is an inferior Sea Islands cotton; and though it has a fairly long staple and a silky appearance, it is more irregular, both as to colour and length of staple, than the pure Sea Islands grown in the United States. It has a length of about $1\frac{5}{8}$ in.

(2) **Rough Peruvian.**—This is a harsh, wiry cotton, with a staple of about $1\frac{1}{4}$ inch. It is an indigenous variety, and is the product of a perennial plant, which attains a height of about 10 ft. On account of its very harsh fibre this cotton is used chiefly for mixing with wool, with which fibre it has some properties in common.

(3) **Smooth Peruvian.**—Smooth Peruvian is a soft class of cotton, very similar to American, from which cotton it is not improbably descended. It constitutes about 70 per cent. of the crop. Staple, about $1\frac{1}{8}$ inch.

In some respects Peru resembles Egypt as a cotton-growing country. It is watered by streams running down from the Andes to the Pacific Ocean. In the hot season the melting of the snows causes an overflow of the rivers, which deposits a rich mud over the cotton fields.

BRITISH EMPIRE.—Though the work of the British Cotton-Growing Association has been necessarily slow, the cotton produced in the new cotton fields of the Empire is now becoming an appreciable item in the world's cotton supply. The figures available shew a production for the year 1914 of 94,300 bales of 400 lb. each, against 28,100 bales in 1909. The accompanying table gives an approximate estimate of the cotton grown in new fields in the British Empire (in bales of 400 lb. each) in the years 1907-14 inclusive:—

APPROXIMATE ESTIMATE OF COTTON GROWN IN NEW FIELDS IN THE BRITISH EMPIRE.

BALES OF 400 LB.

	1907	1908	1909	1910	1911	1912	1913	1914
Gold Coast	250	200	200	100	100	120	100	100
Lagos	9500	5500	12100	5900	5800	8900	14000	14000
Southern Nigeria	250	200	300	300	300	270	200	200
Northern Nigeria	1500	500	400	400	600	2600	2000	2500
West Africa	11500	6400	13000	6700	6800	11890	16300	16800
Uganda	2000	4000	5100	12000	20000	29000	26000	41000
British East Africa	200	300	300	400	500	900	1000	500
Nyasaland and Rhodesia	2500	2100	2800	3400	5300	7200	7500	8000
East Africa	4700	6400	8200	15800	25800	37100	34500	49500
Sudan	?	?	?	15000	21000	15000	20000	20000
West Indies	6500	7000	6400	5500	6500	6500	7000	6500
Sundries	300	500	500	500	700	1000	1000	1500
Total	23000	20300	28100	43500	60800	71490	78800	94300
Approximate Value	£263000	330,000	450,000	696,000	840,000	952,000	1,170,100	1,220,000

West Africa.—A cotton of a similar class to American is grown in Lagos, the Gold Coast, and Nigeria. There is now a good demand for the cotton in the Liverpool market, and with an extension of the railways and other methods of transport a much larger supply may be looked for. Mr. Worsley, the Association's manager, who recently returned from Northern Nigeria, reports that there is no doubt that something like 7,000 bales are produced annually in the Zaria district alone; this cotton is purchased by the native traders for the local weaving industry in the Kano district. Mr. Worsley considers that the prospects in some of the districts recently opened up are distinctly promising.

Uganda and East Africa.—The quality of the cotton produced in Uganda is fairly good, and is filling a distinct want, as it can be sold as a substitute for the better grades of Texas at prices ranging from 50 to 120 points on Middling American. In British East Africa the progress made has so far not been very great.

In view of the recent financial troubles, and the low price of cotton, it was feared there might be some difficulty during the coming season in buying and financing the cotton crop, which is estimated at about 50,000 bales. A scheme was accordingly drawn up by the Association, whereby all the necessary funds could be obtained, amounting to about £600,000, which would enable the native producers to market the whole of their crop. The scheme was submitted to the Government for approval, and is at present under consideration by the Treasury.

Soudan.—In the Anglo-Egyptian Soudan, cotton of the Egyptian variety Mitafifi is being grown; and though it is neither so regular nor so clean as Egyptian, there are good prospects of improvement, and of the production of a large quantity of useful cotton.

West Indies.—Most of the cotton grown in the West Indies is of the Sea Islands variety. Though the prices obtained are not so high as for Sea Islands proper, the cotton is of a very good quality, and is being used for fine counts and good-class yarns.

Nyasaland.—On the 19th ulto. a meeting was held with Mr. McCall, the Director of Agriculture for Nyasaland, who gave an interesting account of the prospects generally for cotton-growing in that Protectorate, both as regards cotton cultivated on plantations controlled by

Europeans and also as to native cultivation. The cotton crop last year in the Highlands was a failure, owing to unfavourable climatic conditions; on the other hand, the crop in the Lowlands, which is largely grown by natives, was the largest on record. Mr. McCall, the Director of Agriculture for Nyasaland, estimates that the lowest cost at which it is possible for Europeans to deliver Nyasaland cotton in Liverpool is 5d. per lb., and this would not leave any margin of profit to the growers. The European planters will, he believes, be likely to discontinue cotton cultivation unless they can obtain more than 5d. per lb., and they will plant tobacco instead. As regards native cultivation, the people are quite satisfied if the Government see that they get full value for their cotton. As to transport facilities, the railway has now been completed from Port Herald to the Zambesi River, and it is felt that the next extension should be made from Blantyre to Lake Nyasa.

An interesting calculation has recently been published as to the effect upon the English cotton industry of the fluctuations in the price of raw cotton. England consumes about 4,000,000 bales each year on the average. At one time cotton could be bought for 3d. per lb. At the beginning of 1914 it was 7½d., and was not lower than 6d. at any time in 1913. A difference of ½d. per lb. makes a difference of (say) £1 1s. per bale, while £3 3s. per bale makes a difference on 4,000,000 bales of (say) £12½ millions sterling.

The price of the raw material largely governs that of the manufactured article, and high prices restrict trade, especially in countries like India, China, Africa, Turkey, and the Balkan States, where the purchasing power of the individual is comparatively limited. It is interesting to note that, if the 350,000,000 Chinese were to consume cotton goods to the same extent as some of the European peoples, it would require more than 20,000,000 bales of raw cotton to supply them. A similar calculation may be made for the now scantily clothed 100,000,000 Africans, so that the expansion of the cotton-goods trade seems bound to take place as these countries become more civilised.

THE LIVERPOOL COTTON MARKET

CLASSIFICATION OF GROWTHS OF COTTON.

AMERICAN is classed by grades, thus:—

Ord.: Ordinary. G.O.: Good Ordinary. F.G.O.: Fully Good Ordinary. L.M.: Low Middling. F.L.M.: Fully Low Middling. Mid.: Middling. F.M.: Fully Middling. G.M.: Good Middling. F.G.M.: Fully Good Middling. M.F.: Middling Fair.

These are divided into half and quarter grades, thus:—

Ordinary.	*Low Middling*
Strict Ord.	Strict L.M.
Fully Ord.	Fully L.M.
Barely Ord.	Barely Mid.
Good Ord.	Middling.

And so on through each grade.

BRAZILIAN is classified thus:—

Mid. Mid. Fair. Fair. Good Fair. Good. Fine.

EGYPTIAN is classified thus:—

Fair. Good Fair. Fully Good Fair. Good. Fine. Extra Fine.

PERUVIAN is classified thus:—

Mid. Mid. Fair. Fair. Good Fair. Good. Fine. Extra Fine.

EAST INDIAN is classified thus:—

Good Fair. Fully Good Fair. Good. Fully Good. Fine. Superfine.

EAST AFRICAN is classified in the same grades as Peruvian.

WEST AFRICAN is classified:—

Low Mid. Mid. Good Mid. Fully Good Mid. Mid. Fair.

WEIGHTS of Various Growths:—
American, about 500 lb. per bale.
East Indian (hard compressed), about 400 lb.
Egyptian (hard compressed), about 730 to 750 lb.
Brazilian and Peruvian vary in weight; the light packages run from 160 to 175 lb.; the heavy ones from 350 to 500 lb.

NOTE.—In fulfilment of Futures contracts for (say) "middling" American, sellers may deliver qualities down to Good Ordinary (the Fully Good Ordinary clause will come into force on September 1st, 1914); but for Spot only the specified quality may be delivered.

An historical sketch of the rise and development of the Liverpool Cotton Market appeared in the 1908 issue of this "Year-Book" (pp. 52-56). Therein it was traced how the ever-increasing business in "futures" gave rise

to the necessity for its being regulated; and that the outcome was the establishment of the Clearing House, and afterwards of the Cotton Bank.

About 1882-83 an agitation took place in favour of periodical settlements for "future" contracts. After much opposition the principle was adopted, and ultimately the custom of weekly settlements became the rule, and this prevails at the present time.

The Futures Market makes possible the moving of cotton from the plantations to the mill without risk of loss from the fluctuations of the markets, and enables spinners and manufacturers to "cover" their sales of yarn and cloth.

There are also other ways by which spinners cover their sales of yarn. These are, by purchasing "cost, freight, and insurance"—termed c.i.f. and 6 per cent. terms; by purchasing for gradual delivery equal to a sample agreed upon, which is mostly sealed until the cotton is tendered; and by purchasing cotton already shipped, either on grade or actual American sample. In all these cases the price can be fixed at the time of purchase, or "on call" within a specified time. Still, whichever mode be adopted, the merchant who sells to the spinner has, with scarcely an exception, to "cover" in the Futures Market.

About eighteen years ago the business in "futures" was done on the "Flags"; but after many attempts to effect a change, and much opposition, this was transferred to the "Room." This "Room" was really commodious, and at the time the change was made the accommodation was thought to be ample. Nevertheless it was later found to be inadequate, and the magnitude of the cotton trade of Liverpool may be best gauged by its magnificent Cotton Exchange, erected in Old Hall Street, and opened in 1906. After providing for the wants of the Association, there are numerous offices and salerooms available in the Exchange to accommodate the merchants and brokers. There are at present about 600 members of the Liverpool Cotton Exchange. The change has conduced to the convenience of those connected with the cotton business, and the facilities offered for conducting both the Spot and Futures departments in the Cotton Exchange itself are such that the volume of business has room to and must expand.

COTTON FUTURES:

What they Are, and How they Work in Practice.

The following exposition of the Cotton Futures Market, written by Mr. CHARLES STEWART, of Liverpool, was originally prepared as a Paper for and read before the British Association, on the occasion of its assembling in Liverpool, in September, 1896. In the opinion of competent judges, it was and still is the best exposition of the subject that has ever been written. The following reprint has been revised and brought up to date (November, 1914) by Mr. Stewart:—

My endeavour is to present a concise and clear explanation of what "Futures" are, free from all avoidable technicalities, and how they operate in practice.

What are Futures? Their very name denotes that they have nothing to do with what is past or present;——and let me state here at once that I am dealing particularly with American Cotton Futures (the greatest field for the exercise of this special kind of operation), although, broadly speaking, the system is applied to other growths of cotton and other kinds of produce.

A cotton crop or a cotton stock in a marketable centre is a thing which exists. When such is offered for sale in bulk, either by sample of the actual thing or by recognised standard, that stock is called "Spot" cotton. It is on the spot—there to see, to handle, to be bought, a something tangible; and in the proper places, instituted by respective markets and associations, a faithful record of the quantities is kept for statistical and general purposes. In days gone by, such known stocks, whether in the United States or Great Britain, or the Continent, were the only cotton that could be bought or sold; and as (say) during the period of the American War, where a consumer could not put his hands on the actual supplies required for the engagements of his spindles and looms, he had terrible possibilities of loss and uncertainty staring him in the face. He could not re-spin his yarn, he could not re-weave his cloth. He could not substitute any other produce for that hungry machinery, although perhaps supplied with its proper food for one month ahead; he knew nothing, saw nothing, but what *was*, even if it were not immediately wanted for use.

Without going into unnecessary details as to how, in the gradual expansion of commerce, a new system grew side by side with increased production, and telegraphic

developments in particular, it is enough to say that one step followed another in a process of evolution—until nowadays, in addition to what is offered for sale in the nearest and most convenient market, a man may buy or sell (as the case may be) upon an acknowledged basis of quality, an equivalent to his actual requirements, or possibilities of production for delivery to him if a consumer, or from him if a producer, quite easily for twelve months ahead, before even the very ground is prepared for the crop which the necessities of the world will require in due time. In other words, from a consumer's point of view (and I specially rather favour here a description of his position, as we in Great Britain are consumers and not producers of the raw material), if a spinner or manufacturer is offered a contract that will employ his machinery and hands profitably for (say) twelve months ahead, the, at first sight, awkward fact that he does not possess the actual cotton for the work, nor the hard cash to buy it, need occasion him no special alarm. With calm, quiet merchanting he can protect himself at once. How does this come about?

We are in the month of November. Looking at a Liverpool cotton market report in the columns of the daily or weekly press in normal times one would find a table of abbreviations and figures, thus :—

7.04	November.	6.87	Feb.-Mch.
6.89	Nov.-Dec.	6.88	Mch.-Apl.
6.87	Dec.-Jan.	C.88	Apl.-May.
6.87	Jan.-Feb.	Etc.	Etc.

Alongside these abbreviated months, which are called "positions," are figures. The first signifies pence, and the following figures so many one-hundredths of a penny per lb. Thus 6.88 means 6.88/100d. What does this mean exactly? First of all let it be understood that the standard previously referred to is the "Middling" grade of American cotton, *the* standard of the trade. Any cotton expert knows what "Middling" American is, just as well as any ordinary man knows what a shilling piece is. Cotton is classed into various grades, fixed authoritatively by experts, for which grades type standards exist. The ruling standard is always "Middling." There are higher grades, there are lower grades, but the standard is fixed. Therefore if a merchant sells a contract for future delivery (say) in November or December for "Middling" cotton at a given price, both seller and buyer know perfectly well what they are deal-

ing with. Nothing else is intended, and nothing else can be substituted, except under certain conditions; and anyhow the basis is unaltered. It is a safe contract for both. Such contracts, however, are subject to a clause which guarantees that the seller shall not tender any cotton below "Good Ordinary," which is lower than "Middling"—he may tender as much higher as he pleases. It may reasonably be objected, "Yes, but if he tenders below the standard grade at his option, how is it fair to the buyer?" The answer is that the buyer in this case has full recourse to an arbitration on the samples of the tender; and just so much as the tender is below *the* standard, so is he awarded by experts (subject to a right of appeal to a fixed Committee) exactly such monetary compensation as the tender is below the strict contract. But, observe, it *must* be within the limit of "Good Ordinary"; anything lower than this is rejected, or a penalty is exacted. On the other hand, if the season be one in which high grades are comparatively very plentiful, the seller may possibly tender higher than the standard; and, subject to arbitration and appeal as above, just so much as the tender is better than the standard, at the ruling prices of the day of test, does the seller receive from the buyer so much more money than the actual price of the contract.

This explanation of the character of the contract carried to finality may be amplified by the remark that a seller who contracts to deliver to the buyer a November and/or December contract is bound to fulfil his engagement on or before 31st December (he may do it at his convenience upon about every alternate business day between November 1st and December 31st) or be liable to a penalty. This remark, however, does not altogether explain all, for this reason :—A man who buys Futures does not as a rule want the cotton itself; a man who sells Futures does not want to provide the cotton. More generally in practice each man's turn is served (as I shall explain later) by his having concluded a contract, in the terms of which he gets perfect protection, for a standard quality at a given price with a responsible firm, and has, therefore, a guarantee which serves as a basis for some other operation of which this is only a part.

Having explained briefly what a contract is, let me show how it works as a contract in suspense, not yet fulfilled. For the working of Futures contracts a most elaborate and complete machinery exists in what is known as the Clearing House of the Liverpool Cotton

Association. Starting (say) with any day during the week, Monday to Saturday, A may have bought from B, and therefore *vice versâ*, say one thousand bales of cotton in the manner cited. For simplicity's sake, let us assume that all these contracts have been concluded on the basis of 4d. per lb. Whatever contracts A has bought from B by the Saturday (from the previous Monday) stand good for next week's settlement, because once in each week the difference in price between buyer and seller must be adjusted in cash. At eleven o'clock on each Monday morning a Committee adjusts what are called the "settlement Prices" of the different positions on the board. This adjustment is open to no question. It is disinterested, and the prices fixed for the different months or positions at eleven o'clock on Monday morning are the exact values of all contracts at that hour. Supposing values have gone up during the week, since the contracts were made, say ¼d. per lb., then the seller is indebted to the buyer for that difference of a farthing. But if values have gone down in the meantime, then the buyer is indebted to that extent to the seller, and the debit balance must be paid by either the one or the other into the Clearing House on the following Thursday morning at 1 p.m., *or the defaulter is posted*.

Although only the difference between the price of the contracts and the value on the day on which the settlement price is fixed, passes between A and B through the medium of the Clearing House, it must not be assumed that a farthing per lb. is of little consequence. Such a difference, on the contrary, is a very important one (there are less differences, there are greater, for prices are constantly fluctuating). It means roundly at least £50 every hundred bales, and as many firms may easily be "long" or "short" ten to fifty thousand bales, 10s. per bale is a decidedly important item. To be "long" is to have bought; to be "short" is to have sold. So long as a contract is "open," that is, either not matured or not "rung out" as the saying is (a process which comes about by the seller becoming a buyer, and the buyer becoming a seller of the same quantity and the position—a practice, with greater or less detail, constantly in operation) the differences have to change hands every week on the basis of the last Monday's striking prices, quite irrespective of the full value of the number of bales interested. This full value, say £8 to £10 per bale, never comes into consideration at all until and unless an actual tender takes place. The proportion of

cotton actually tendered and accepted is in the highest degree quite infinitesimal compared with the contracts entered into. It must not be assumed, however, that a contract can only be reversed and closed out on a Monday at 11 a.m. simply because the striking price is fixed then. A contract is liable to be closed at any time; and if this, for example, should be done say on Tuesday, or Wednesday morning or afternoon, and so on, the difference due on that contract is that between the Monday's striking price and the value at the time of closing.

In plain English, let me state further—because I know that much misconception obtains on the point—that if a buyer or a seller, through his broker, buys or sells say to-day one hundred bales or more for Jan.-Feb. delivery, and, his purpose served, he sells or buys again in November, or at any intervening time, the same quantity of the same position, his responsibility in such contracts terminates *at once*. All that he has to do with is the difference between the price at which he bought and at which he sold, and his liability in a contract is *at an end*, whether it applies to a delivery one month away or twelve months away; and it is of no consequence whatever to him if the purchase is from Smith and the sale is to Jones. The responsibility rests with the broker, and it is adjusted between him and the Clearing House.

Now, having, as I think, made this tolerably clear, let me ask the reader to follow me in my attempt to explain how this "Futures" machine works in its various ramifications towards the attainment of its great objective, namely, in its movement and moving and use of the American cotton crop. With this object I divide my remarks into two main divisions—the first dealing with Futures as Sales, the second as Purchases.

FUTURES AS SALES.

It takes the Sales first, as the first transaction that can happen with a marketable commodity necessitates that the possessor must be a willing seller. We will divide this consideration of "Sales" into three sections :—

1. The Use of Futures to enable a Planter to Secure a favourable Price while his Crop is Growing.

In times gone by the tiller of the soil toiled away until harvest time, gathered his crop, got it to market somehow or other, and sold his produce for what it would fetch; generally speaking when thousands of his neighbours were doing the same thing. The natural result

was congestion, a universal demand for cash or exchange, and according to circumstances a greater or less diminution in value. For the farmer must have bread and clothing for his family, fodder for his cattle, oil for his lamps, fuel for his fires, and stores of all kinds for consumption. His cotton was of no use to him itself. It was his currency to buy the necessities of life, and must be exchanged. With it he bought, and buys, the dollars with which to pay for his rent and other charges; and if he could unload *only* at the time of harvest his property ran a great chance of depreciation, because everyone else was unloading about the same time.

Well, it may be asked, Where do Futures come in? They come in here. No man knows better than the farmer what his green and afterwards snow-white acres are likely to yield him. His crop may be according to locality—a quarter, a third, half, or even a bale to the acre (a standard bale, by-the-way, weighs 500 lb.). Let us assume that some great financial or commercial depression appears to be looming ahead in the autumn, or other violently disturbing feature like a Presidential Election, with the possibilities of a congestion at harvest time of a great crop, and values down in the commercial marts of the world to all but the bare cost of production, if not below it. What a gloomy outlook for the realisation of hours and days and weary months of labour! Without the Futures market the planter would be at the mercy of events, or the money-lender. In the July previous to the reading of this Paper (Sept. 21st, 1896) "Middling" American in Liverpool was as low as 3¾d. per lb.; the same standard for delivery in November was 3⅝d. per lb., while 75 per cent. of the cotton world confidently expected, and with some reason, that it would go down to 3d.—a price which would have meant dead loss on the plantation.

What happened in the August? From various causes prices shot up 1d. per lb. in a few weeks—and from comparative ruin every planter was raised into opulence if he could have sold then. Yes, but he could not exchange for cash what did not exist except in green stalk and undeveloped cotton bolls! But he could and no doubt did in many cases protect himself, and although prices might go higher (and did go higher), at 3 to 5 cents per lb. above cost of production, he was well off if he could realise his probable outturn, whether one hundred or five hundred bales. How could he do it? Easily enough. He had only to give a responsible broker

in any recognised Cotton Exchange an order to sell so many hundred bales of Futures for October, November, December, or any other month's delivery, at the current good prices then ruling, and sit on a fence whittling sticks if he liked, while his crop matured, was picked, delivered, and sent to market. His price was secured; all he had to do was to deliver. Could he have done this without the aid of the Futures market? Certainly not.

2. The Sale of Futures as a "Hedge" by Importers against Shipments.

We will now consider what I have classed as the second section under the heading of Sales of Futures. This section is second to none in importance, if indeed it is not the most important and legitimate function of the system, namely, the sale of cotton Futures as a "Hedge" by importers against shipments. Even by many people interested in the cotton trade this is only indifferently understood; and I have no hesitation in affirming with emphasis that were it not for the Futures market, the crop nowadays simply could not be moved, except in the light of a sheer speculation.

To bring this home, it is necessary again to revert to the time when no Futures market existed, bearing in mind too that crops then were only one-third to one-half the size of what they are to-day. In that out-of-date period then, the importing of American cotton was in comparatively few hands. The firms who did the merchanting were generally very wealthy, and their capital made them monopolists. Their agents in the States bought when they thought the article cheap, negotiated their drafts on the home house or paid cash, shipped the produce, and trusted to luck or good judgment as to what kind of market the cargo would reach on arrival upon this side. As it is only within recent years that the supply of the raw material has for any length of time materially overtaken the demand in Europe, the main purchases were only concluded in a time of congestion at the sources of supply, and the farmer's necessity was the merchant's opportunity. Remember there were no telegraphio advices in those days. Invoices and bills of lading came with the goods; ocean transit was much more tedious, if not more dangerous; and many causes of more or less local interest sometimes occurred and combined—so that, while it is quite true that the cotton *might* arrive upon a market greatly advanced in price between the time of shipment and arrival, it was also

equally liable to arrive on a market depressed, thus making the venture a serious loss, if realisation had to take place.

Fluctuations in those days were great. One halfpenny or one penny or twopence per lb. variation in the course of a few days or weeks was not at all an uncommon thing; and when I remind you that ½d. per lb. profit or loss means, on 1,000 bales, no less than £1,000, the risk is apparent. Profits were greater than to-day, and this fact no doubt answered in compensation for losses on a year's trading; but it was only the large capitalist who had a ghost of a chance to succeed, and the trading was not regular as we know it to-day, it was opportunist. Yet, wealthy as many of the great houses were, the immense failures and losses which the "Flags" of Liverpool have seen in consequence of the utter absence of protection against loss, are to-day spoken of as experiences completely out of question, in the light and practice of the facilities offered by Futures for modern commerce.

Well then, to-day, an importer through his agent buys in America a line of cotton, it may be 100, it may be 10,000 bales. The purchase is advised home by cable instantly, a drawee is found, the cotton is shipped, and by a sale of Futures either in Liverpool, New York, or New Orleans, or any port where a Futures market exists, to the exact weight—or as near as possible—of the purchase, the importer is absolutely protected against loss, whether the market declines 1/100d. or 1d. per lb. before its arrival. "How does this operate?" you ask.

In the first place, naturally the purchase is made upon a recognised basis of quality, which is not only effective here but in the United States also. To the cost of the cotton is added the freight and insurance necessarily incurred in transport, financing, landing and warehousing charges here, a small commission for profit (for a rapid turnover is what is generally aimed at), and all these charges, say, bring out the actual value at 5d. per lb. (any price will do for example's sake). A sale therefore of Futures of a position, say October and/or November at this price, during which months the actual cotton would be due to arrive, would be a perfect "hedge" —because if necessary the cotton upon arrival could be tendered against the Sale, and would be a complete fulfilment of a Futures contract if carried to finality.

This purchase and shipment, if properly conducted, will therefore just work out at the market price of

Futures delivery for the month or months in which the cotton is due to arrive as described; for (putting it in another way) from the price of the Future have to be deducted all the costs of the transaction before the price can be fixed for the original purchase, minus charges. Now all this being effected, it is of no consequence whatever, broadly speaking, whether the cotton markets rise or fall between the time of the purchase and the arrival of the shipment. Why? All "Spot" business is based upon the value of Futures. As these latter advance or decline, so generally does the value of Spot "Middling." If general values have declined before the arrival of the cotton, so that the actual bales of the raw material must be sold to the consumer at a lower rate than the original cost, therefore showing a face loss—then also the Future contracts sold as a "hedge" against the purchase before shipment, have declined, and can be bought back again at the decline. For example, if the entire consignment were to be sold on arrival, the Futures "hedge" would simultaneously be bought in the open market. One leg of the transaction would show a loss; the other leg would show a corresponding profit. So far as the hedge was concerned, the loss on the one leg of the transaction would be balanced by the profit on the other. Let it be remembered that the question of profit on the shipment has already been taken into consideration before the contracts were entered into, for if a reasonable profit were not assured or anticipated the trade would not have taken place. The principles laid down here are fixed; they regulate the business done, and it is only upon the basis of them that modern importing is conducted with any degree of safety.

Let us, however, go into everyday practice a little further than in assuming that a cargo is sold immediately upon arrival. It is not always so treated by any means—witness the fact that American cotton stocks fluctuate in Liverpool between (say) half a million and two million bales. A shipment arrives in dock, is warehoused and sampled, and on these samples it is offered for sale. The shipment is (say) 1,000 bales, possibly divided into ten lots of 100 bales, each slightly differing in character and value from the others. Nevertheless, the *basis* on which they were bought is unalterable and unaltered. It is *most* important to remember this. It frequently takes some time to dispose com-

pletely of a shipment: once warehoused, it is quite the exception for a big block of cotton to be sold at once. Well, then, you ask, how are the Futures dealt with? A thousand bales were bought, and a thousand Futures sold as a hedge. Just so. And if to-day from the warehouse, one hundred out of the thousand are sold to a consumer, and one hundred Futures are bought in at *the same time*, the hedge expires for that one hundred and so on until the lot is cleared out.

It is not difficult to see now that, granted a common basis for business, such trading can go on all the year round so long as there is one hundred bales of cotton offering from the other side. Thus the trading is not opportunist, it is regular. It is immaterial to the shipper whether price be high or low. With his basis right (and the planter cannot sell if it is not), and his hedge assured, the business—that is, the moving of the crop—can go on with regularity utterly independent of whether values are rising or falling—down at bottom prices, or away up out of sight; and the small capitalist can avail himself of this system as well as the great. Further, not only is the trading not opportunist, but it cannot be monopolised. Congestion and its necessary accompaniment, unduly low prices, are avoided.

I have not used the term before, but I think the Hedge of cotton by a sale of Futures against a Shipment will have suggested already to the reader's mind that it is a perfect form of insurance—insurance against loss in value. And to whom? The merchant only? Not at all, but also to one without whom the merchant or importer simply could not get along. I mean the Banker. I am not referring at all to marine or fire insurance; that is another matter, with which we have nothing to do here. Our insurance is against loss in value, and it affects the banker equally with the merchant. Why? Simply because with very few exceptions indeed, a merchant is very rarely drawn upon direct by the original seller of the cotton. Some well-known financial house is drawn upon, accepts the bills, and holds the documents and warehouse receipts. The handling of the cotton in such a case is only done by the importer on trust for the banking house, although the profit or loss belongs to the importer. The hedging of the shipment by a sale of Futures is as important to the banker as it is to the merchant; it is his guarantee and insurance that whether the cotton upon arrival be worth the original drawing price or whether it be not, the sale of Futures

has protected the transaction to the extent of the decline, and that whatever deficit on one account may occur before realisation is complete, it is fully made up on the other.

Try to imagine what a security to a bank this hedge is if you can. One bank alone may very easily be financing half-a-million bales of cotton. A drop of ¼d. per lb. between the acceptance of the drafts and maturity for such a quantity would mean a deficit of £250,000. Such a possible risk if there were no protection by the Futures sale would stop business almost altogether. In a word, any merchant now-a-days importing cotton without hedging it by a sale of Futures would be carrying on his business as a sheer speculation, and whatever his reputed means, no bank would trust him any farther than his available securities in its hands would warrant. Indeed, it would rather not have the account at all.

3. The Sale of Futures to Insure against Unsold Stocks of Yarn and Cloth.

We will now consider a third manner in which Futures are profitably employed as "hedge" sales, namely, in protection to spinners, manufacturers, and their agents, against unsold and possibly accumulating stocks of yarn and cloth. Imagine a period of distressed or disturbed trade, when producers cannot sell their goods, and yet where they are not compelled to stop their machinery. Under these conditions a producer is "making to stock." Nothing is more likely than that he is doing so in falling markets, that every pound of yarn and piece of cloth added to stock is losing in value every day. Not only is he producing at a loss in an idle market, but that which he has produced is also further losing day by day in value.

A man may have to wait months before he can dispose of his yarn or cloth. In the meantime he may easily be ruined. He can sell cotton Futures in the twinkling of an eye. There is always a market; always and immediate. Cotton Futures are the Consols of produce. They may not be a perfect hedge as a sale against manufactured goods; as a matter of fact they are not so, but they at least are the most perfect hedge obtainable in the world. Pound of raw cotton for pound of yarn or cloth, they are the best sale he can make, and he "covers" himself accordingly until the tide turns and better markets are secured. As the value of his yarn and cloth declines, the value of his Futures also

gets less than the price at which he sold them; and at least to some extent what he loses on the one hand he reaps on the other—for it can easily be understood that the value of raw cotton affects all plain cotton goods. Of course, here is a case distinct and plain, in which a seller has no intention in the world of tendering the actual cotton against his sale; still less does he want to tender either cloth or yarn, although he may possess it. He could not do the latter even if he wished, but he makes a convenience of selling a paper contract of so many pounds of the raw material on a given basis, at a given time, and when the convenience is served, he buys back a paper contract which cancels that representing the sale, any conditions of differences in and between being dealt with as they arose, as explained at the beginning of this paper.

FUTURES AS PURCHASES.

We have now done with the general utility of Futures as hedges against stocks of the raw material, whether on the plantation, on shipboard, or in the warehouse, or as hedges against accumulated stocks of manufactured or manipulated cotton goods, and will therefore proceed to deal with Futures in an exactly opposite sense to that already considered. We have dealt with them as Sales; we will now treat with them as Purchases—the whole idea of their utility in either capacity being one of insurance against loss in value in other operations, having one recognised standard of the raw material as a basis.

Against Forward Deliveries.

In the first place, then, as Purchases we will treat them "As hedges by shippers against sales of forward deliveries, when the actual cotton for this delivery has still to be brought from the producer or his factor." In much the same way as a planter wants to sell Futures against his growing crops, and thus secure what he considers a fair price for his work long before he is ready to market his produce, so does a shipper, conscious or anticipatory of a good trade ahead, want to have something in hand, while his agents are busy (say in Europe) getting orders for that which is growing and coming on to market for use. The practice therefore comes about in the following manner.

All cotton is not bought by a customer from a known stock, neither will a purchase of Futures for delivery to him in any of the months on a basis "Middling"

standard suit his exact requirements. Yet it is not only quite possible, but also quite frequent, for him to make a contract, termed a "c.i.f." contract, with a merchant, to deliver to him at a specified time a special description of cotton, a special length of staple, a special strength, a special grade, a special style. The letters c.i.f. (or, strictly speaking, c.f.i.) mean, C. cost (the original cost of the article), F. the freight, and I. the insurance.

Upon calculations, unnecessary to detail here, a shipper of cotton will offer, generally during the summer months, to deliver consignments ahead with the above specialities, to any consumer who wishes to buy them. Contracts pass between seller and buyer, and are equally binding upon the one to provide and the other to receive. The seller to some extent naturally takes a legitimate merchant's risk while the crop is growing. His emissaries are all over the cotton field, on the look-out to secure the raw material to fill the contracts made and report the progress of the growing plant. Crop prospects, let us say, deteriorate; the possibility of being able to secure the exact thing required becomes doubtful. Meantime prices show a tendency to rise, and the price at which the sale was made runs a chance of being passed. The planter turns stubborn, and holds for higher prices, a "bull" fever takes possession of the world, and by leaps and bounds cotton gets upon a higher plane of value.

This would be particularly embarrassing to the shipper if he had no loophole through which to extricate himself. He is already in a temporary dilemma in being placed in a position in which he cannot lay his hands upon what he actually wants and has sold, but this is a mere detail, and secondary to the importance of values getting away out of his reach. It is *value*, and the difference between loss and profit, which is all important to him. What does he? He covers his financial responsibility by buying Futures in an accredited market. The market then, broadly speaking, may do what it likes. If he has a thousand bales sold c.i.f. ahead, and local or general circumstances combine to prevent him from providing himself with the actual thing wanted, but he has a thousand bales of Futures bought as a "hedge" against possible advancing value; he is fairly safe. As much more as he may have to pay for the actual requirement in order to fulfil his contract, so much more is the difference on the Futures contract worth to him to fill up

the deficiency; and when he has secured by purchase and selection that which he has contracted to deliver he sells out his Futures contract, which is no longer necessary to him.

As, however, Futures exercise one great function as Sales—that of hedges against the imports already described—so do they exercise one special great function as Purchases. This undeniably immense field covers those operations in which they are bought as hedges against sales ahead of yarn and cloth by producers of these, by their agents, and ofttimes by the merchants who ship goods abroad.

At the outset I alluded to the fact that if a producer of cotton goods is offered a contract that will keep his spindles and looms going, and his workpeople employed, for twelve months ahead—even if he did not possess the raw material required, nor the available cash with which to purchase it, even also if it were (as it is not always) in existence to be purchased—he need experience no special alarm; for with quiet calm merchanting he can protect himself at once.

Against Sales of Yarn.

We will now go on with the "Purchase of Futures as a hedge against sales of yarn." On the boards of the Manchester Royal Exchange are to be found, practically every day in the week, the principals or representatives of every cotton spinning mill in the Kingdom. Spinners from all parts congregate there to sell their yarn. We will imagine a busy time, meaning considerable demand. Large lines are being placed. Buyers are more needy than sellers, and they are not merely anxious to purchase a quantity of any special firm's production for immediate delivery, but possibly still more anxious to enter into engagements for the full or main part of the production of such and such a firm for many months, even up to twelve months ahead. The spinner has capital, it is true; but if his consumption of the raw material were only 100 bales per week, and the contract offered were only for six months—under old conditions of only being able to lay his hands upon what *was*, in the shape of cotton, available, and pay cash for that, he would have to expend no less than £26,000, and stow the cotton away somewhere until it was used up; either this, or take his luck or chance in picking it up in driblets as he could, or as his spare money allowed him to do.

Thus with the aid of the Futures market, any spinner of decent repute and very moderate capital can

quietly consider such a long contract as suggested, accept it, and "cover" himself in five minutes, insuring himself against all loss. As I have said before, on the basis of Future values is the value of all cotton, therefore of cotton goods. On that basis, or about it, after much bargaining, the contract for yarn is concluded; therefore without waiting to proceed to the raw material market to select his actual and special requirements, the spinner has simply to telephone or telegraph down to Liverpool to his broker to buy so many hundreds or thousands of bales of Futures, 200 of this month, 200 of next month, and so on; and all risk to his profit, so far as providing his requirements for his engagements, is past and gone. He can go home and sleep, leaving it to more convenient seasons to effect his actual purchases and requirements of the raw produce. As he effects this latter from time to time in lots of 100 to (say) 500 bales, so does he part to the same extent with the Futures already bought. If the market has risen in the meantime, as much more as he may have to pay for his actual wants, practically so much profit has he upon his Futures contracts—the one balances the other. We have already seen the reverse of the operation in other business. If the market has fallen in the meantime, true, he will have a loss upon his Futures, but then he has the less to pay for his actual cotton. The basis of his trade is not altered one whit. In other words, granted that his first calculations are correct, based on the value of Futures at the time he enters into an agreement to supply yarn for forward delivery, and that he buys his Futures there and then, so far as his buying or selling are concerned, risk and loss are out of the question.

Against Sales of Cloth.

This is no less true when applied to purchases of Futures as against sales of cloth by manufacturers. A maker of cloth, like a producer of the yarn which makes the cloth, frequently sells his production for many months ahead. True he cannot weave Futures, any more than a spinner can spin them; but oftentimes he cannot get the yarn he wants, any more than the spinner can select and secure the actual cotton which he requires. The manufacturer therefore cannot afford to run the risk of making a loss by waiting on the yarn market to accommodate him as to price. He therefore buys cotton Futures equivalent in poundage to the weight of yarn he needs; and he also is protected at

once. There is plenty of yarn for him, he knows; but he may get a better chance of securing his possibly million weight of yarn than at the moment of his sale of cloth. As he picks up his yarn, so to the same weight does he dispose of his Futures. He has been insured against loss. Yarn agents and cloth agents follow the same process; so do the merchants who ship and contract to ship goods abroad.

The value of a house may have nothing in the world to do with the current prices of bricks and mortar, iron and timber. But cotton goods are not made out of these, nor out of wool or sugar, but out of cotton alone; and a rise or fall in the value of the raw material is a sure indication of a rise or fall in the value of the yarn or cloth made from it. Therefore on broad lines of value a purchase or sale of a Futures cotton contract, which is always possible, is the next best purchase or sale to that of the manufactured article, which at the moment is *not* always possible.

In the foregoing, the broad principles regulating the legitimate use of Futures have been set forth, and I claim that these broad principles are constantly in practice, and unassailable.

Liverpool. CHARLES STEWART.

LIVERPOOL AS A SPOT AND FUTURES MARKET.

For over a century, in fact since Cotton Spinning was seriously established as a great commercial industry in the last quarter of the eighteenth century, Liverpool has played the important rôle of chief importing and distributing centre for all varieties of cotton. The following figures will give an idea of the progress made during the last hundred years:—

ANNUAL IMPORTS OF COTTON INTO LIVERPOOL.

Year	American	Brazil	East In.	Others	Total
1808-09 ...	38,000 ...	50,000 ...	13,000 ...	†67,000 ...	168,000 bales.
1913-14 ...	3,492,000 ...	286,000 ...	170,000 ...	*806,000 ...	4,754,000 ,,

† No Egyptian. * 570,000 bales Egyptian included.

CONSUMPTION IN LANCASHIRE (all sorts).

1808-09:—210,000,000 lb. 1912-13:—2,200,000,000 lb.

These enormous increases have been brought about by the geographical position of Liverpool as a port, its shipping facilities and ready means of transit, its proximity to the great spinning industry of Lancashire, and especially by the activities of the Liverpool Cotton

Association, whose endeavours on behalf of the trade at large have been copied by all other Cotton Exchanges.

The advantages of the Liverpool Cotton Exchange are many, and offer to all, whether shipper, importer, buying broker, or spinner (British, American, or Continental alike), equitable trading, under Rules and Regulations that provide for all parties, with penalties for any infringement of Rules by any member or members of the Liverpool Cotton Association, Limited.

The Liverpool Cotton Market is the largest SPOT market in the world, no other centre approaching it in quantity of stocks or in the variety of growths offered for sale. Some idea may be gleaned from the following list of varieties of cotton offered in Liverpool for sale:—American, Egyptian, Brazilian, Peruvian, West Indian, Smyrna, East Indian, Chinese, African, Greecian, etc.

The stock of all sorts of cotton in Liverpool during the maximum week of the season 1912-13 was 1,475,000 bales on Feb. 7, 1913. The stock at New York on the same date was 134,000 bales, at New Orleans 138,000 bales, at Bremen 514,000 bales, at Havre 478,000 bales, and at Bombay 614,000 bales.

Dealing with the Liverpool stock, let us now see how it is controlled, *American* being taken as offering the best illustration. During the latter part of July and early August the majority of merchants and importers in Liverpool send out their representatives to the United States, with instructions to buy certain styles of grades and staples on favourable terms, suitable for the requirements of the British spinning industry. (As year by year the better class of cotton goods are being manufactured by the Home Trade, low grades of cotton are very little in demand.) In some cases, brokers in the Liverpool market send their offers direct to American buying houses having centres in the larger interior towns. There are several minor methods employed in importing, but of a detailed character.

Samples are submitted from the States, called types, offers are made to the importers by cable, and, if the offer be accepted, the purchase of actual cotton is covered immediately by a sale of "Futures" in the Liverpool market. Another system adopted (chiefly by Continental houses) is as follows:—On instructions from spinners and to secure future requirements, Futures of very distant months are bought in Liverpool at the discount prices. These contracts are locked up until the month of

maturity is reached, when upon instructions from the U.S.A. that the particular cotton contracted for (say Fully Good Middling) has been secured upon a profitable basis, Futures equal in quantity are sold out on the Liverpool market.

It is sufficient to deal with the cotton shipped from the other side *en route* for Liverpool. All cotton arriving in Liverpool becomes subject to the laws of the Liverpool Cotton Association. To quote the laws and bye-laws at length would occupy too much space, but a few of the most important may suffice to show how the interests of both buyer and seller are safeguarded. Take a shipment of "C.i.f." cotton: It is controlled by the following document—Contract Form 10—to come into force 1st September, 1914:—

COST, FREIGHT, AND INSURANCE CONTRACT FORM (AMERICAN COTTON).

Port and/or Custody Bill of Lading.

(9th October, 1913.)

LIVERPOOL,.......................................

Messrs...

We have this day....................Bales.......................Cotton, averaging, per 100 Bales gross, 50,000 lb. for all descriptions excepting Texas and Arkansas Cotton, which shall average 53,000 lb., and all other Gulf Cotton, including Alabama and Oklahoma, which shall average 51,000 lb. per 100 bales gross (a variation of 5 per cent. allowed), Cost, Freight, and Insurance, for ....

....

(*a*) at ....per lb

or

(*b*) at............points...............the Seller's price of............... delivery (Middling American F.G.O.C.) in Liverpool at the time of call. The Cotton to be called in lots of not less than 100 bales on or before..................but not later than the declaration of marks and ships' names. Calls to be made on the Single month.

To be invoiced at American actual gross weight, less an allowance of six per cent.

(*a*) Gross landing weight guaranteed to be within one per cent. of gross invoice weight.

(*b*) Net weight (that is actual weight of bales, less Bands and 3 9/16ths per cent. allowance for Canvas after deduction of Bands), guaranteed by Sellers equal to Net American invoice weight. Settlement to be made with mutual allowances as to weight.

To be shipped during............................ per.................................

from .... to .... via ....

Invoice with full particulars to be rendered to the buyer within four weeks of the date of Bill of Lading.

Marine Insurance (which does not cover war risks) shall be provided by the seller with... including particular average and country damage, and covering 5 per cent. in excess of Invoice cost, or in the case of Cotton sold on "Call" 5 per cent. in excess of market value up to the "Call" price. Any amount over this shall be for sellers' account in case of total loss only. The cost of stamping documents to be borne by the seller.

After the date of the "Call" Marine Insurance on any increase in value over and above the "Call" price is at buyer's risk.

In case of any casualty occurring after declaration has been made (the Cotton not having been "Called" previously), the seller shall immediately notify the buyer, in writing, of the same, and the "Call" shall be made not later than noon of the first business day following such notification.

(1) Reimbursement by M..................Drafts upon M.................. at............................days' sight for Invoice amount. The buyer guarantees the due protection of the Drafts on presentation and payment at maturity.

or

(2) The due date of Invoice shall be the 75th day after date of Bill of Lading, payable in Liverpool.

(*a*) Payment shall be made in exchange for Shipping Documents on, or (at buyer's option) before, arrival of the Vessel or Vessels; or, failing previous arrival, not later than due date, by cash, less customary rebate for any prepayment.

or

(*b*) Payment shall be made in exchange for delivery of the Cotton as it may arrive (the buyer paying all Liverpool charges) by cash, less customary rebate for any payment made before due date, or plus interest at 5 per cent. per ann. for any payment made thereafter. If any cotton declared under this clause be lost in transit, the Contract for such Cotton shall be completed by the seller collecting for the buyer the excess agreed to be insured over invoice amount. In event of damage, covered by Marine Insurance Policy, the seller shall collect the amount of same from the Underwriters, on buyer's account.

No allowance to seller. Should arbitration be demanded by the buyer the Cotton shall be subject to mutual allowances, except in the case of average shipment. Should any lot prove inferior to..........................the buyer to have the option of accepting the Cotton, or of returning it to the seller under the provisions of Rule 468.

This Contract shall not be cancelled on any ground, and is subject to the "Rules of the Liverpool Cotton Association," whether endorsed hereon or not, and in case of any question or dispute the matter shall be settled in accordance with such Rules.

No Penalty. Yours faithfully,

....

Contracts on very similar lines are also framed for Egyptian and East Indian cotton.

In making calculations on the cost of buying C.I.F. cotton at a well-known interior Southern American market and bringing it to Liverpool for sale here as Spot cotton, the merchant allows for a difference of about 35 points (£70) to cover the cost of freight and insurance on each 100 bales.

———

Next comes the ordinary Arrival Spot Contract, but this is now practically obsolete.

———

The Contract for Deferred Delivery of Spot Cotton, and for Forward Delivery of cotton sold on Spot Terms, is as follows [Contract Form 3] :—

AMERICAN COTTON.

(24th April, 1914.)

CONTRACT NOTE FOR—DEFERRED DELIVERY OF SPOT COTTON, FORWARD DELIVERY OF COTTON, SHIPMENT OF COTTON, COTTON "TO ARRIVE"—"SPOT" TERMS ("FIXED PRICE").

LIVERPOOL.............................191

Messrs..

....

Dear Sirs,

We have this day..

....

the following COTTON:—

Mark	No. of Bales	Description	Ship	Price	
....	....	....	....	....	....

(*a*) In case any bales are found to be not equal to the selling sample or quality contracted for, the seller shall have the following options:—

(i.) Such bales may be exchanged once immediately or

(ii.) A second tender may be made at any time within the period allowed for each delivery under the Contract, but this provision shall not be applicable where the Contract provides for the delivery to be at buyers' option or

(iii.) Such bales may be invoiced back according to the provisions of Rule 570,

or

(*b*) Should any lot prove inferior to....................the buyer to have the option of accepting the Cotton or invoicing it back to the seller according to the provisions of Rule 570. For the purpose of this rule each.................. bales shall be considered a separate contract.

Rule 365.—Payment for all descriptions of Cotton except Sea Island growths shall be made in cash within ten days from Invoice date, or before delivery, if required. Payment for all Sea Island growths shall be made in cash less one-and-a-half per cent. discount within ten days from Invoice date, or before delivery if required. In the case of all Sea Island and Egyptian growths special terms of payment may be arranged between buyer and seller at the time the Contract is made.

This contract shall not be cancelled on any ground and is subject to the "Rules of the Liverpool Cotton Association," whether endorsed hereon or not, and in case of any question or dispute the matter shall be settled in accordance with such Rules.

Yours faithfully,

No penalty. ....

Arbitration.

Practically all contracts made on "Liverpool terms" are subject to arbitration. On Spot or C.i.f. cotton any member of the Association is eligible to act as an arbitrator. On Docket or Tendered cotton, however, the system followed is as follows:—Twenty-seven members of the Association are elected by ballot yearly to serve on the Arbitration Committee, and the nine receiving the largest number of votes constitute the Appeal Committee. The Association appoint an arbitrator each to buyer and seller of Docket cotton, and the arbitration must take place in the Arbitration Room of the Association, at a time arranged by the two arbitrators. On C.i.f. or Spot cotton, however, the arbitration can take place in any sale-room agreed upon. The awards of the arbitrators are subject to the right of appeal to the Appeal Committee, who control all disputes between arbitrators, and whose decision is final.

Standard samples of cotton in duplicate (one set "Reserved" and the other "Working"), of various grades, are made up by the Appeal Committees of the various growths, and are kept in possession of the Secretary at the Association Rooms.

The Working standards are available in the settlement of Arbitrations and Appeals, and are open to the inspection of members. The Reserve sets are not altered without the express authority of the Association, and the Working and Reserve standards are compared monthly by the Appeal Committee. In the case of American cotton the standards are renewed once a year.

The "Spot" Market.

The actual purchase or sale of Spot cotton is accomplished in the following manner (excepting where a spinner buys "on averages"):—

A spinner notifies his Liverpool broker that upon such and such a day he will be buying a certain style of cotton. The broker (through his staff) informs the selling brokers' representatives, who are waiting in force in or about the Exchange each morning about 10 o'clock, of his requirements. (During the present war [December, 1914] the buying brokers write their requirements upon a large blackboard in the "room.") Samples are then sent in to be submitted to the spinner, assisted by his broker. Perhaps 50 to 100 lots of different cotton, but all of the style required, will be presented for sale. A selection is made and the price bid to the seller, who, if he accepts, covers his sale by a purchase in the Futures Market, a subject dealt with elsewhere.

The cotton being bought, delivery is taken by the buying broker, who charges commission at the rate of ½ per cent. of the gross value of the cotton, plus cartage and porterage charges as under:—

For lots of 5 bales and under	1s. per bale.
,, ,, ,, 6 to 10 bales	9d. ,,
,, ,, ,, over 10 bales, of bales weighing 350 lb. and upwards ...	6d. ,,
,, ,, ,, over 10 bales, of bales weighing 250 to 350 lb.	4½d. ,,
,, ,, ,, over 10 bales, of bales weighing under 250 lb.	4d. ,,

It is understood that when cotton is offered for sale, unless the contrary be expressly stated, the bulk of the lot is ready for delivery. The buyer is entitled either to cancel the contract for any portion that cannot be delivered, or to claim that the average date on which the cotton was ready for delivery shall be the date of the invoice. Should any inferior bales turn up at the scale, they are placed aside for subsequent settlement, and the delivery of the remainder is proceeded with. Cotton must be taken by the buyer within ten days of the date of invoice, and payment must be made within ten days from the date of invoice, unless otherwise arranged. Interest at the rate of 5 per cent. per annum is allowed on money paid before the due date, and is charged at a like rate from that day to the day of payment, together with warehouse rent and insurance charges.

In the case of buying "on averages" (mentioned previously), the broker forwards small samples of cotton—

called " averages "—to the spinner, who selects and makes a bid by telephone or telegraph. If accepted, the same conditions apply as in Spot purchases.

When the buying broker has taken delivery of the cotton from the selling broker, it is forwarded to the mill, where it is broken up. Should, however, any of the bales prove faulty (*i.e.*, reveal excess of tare, error in weight, damp or wet, or be falsely packed), then claims are made (all being provided for by the Bye-laws of the Liverpool Cotton Association) on the selling broker, who either accepts the responsibility or reclaims on the American shipper.

The selling broker charges ½ per cent. on the gross value of the cotton to the merchant for whom he is selling the cotton, and the buying broker charges a similar commission to the spinner for the purchasing of the cotton.

" Spot " Sales.

At 11 o'clock daily, the estimate of the daily sales of Spot Cotton, generally ranging from 7,000 to 15,000, is posted in the Room. In extreme cases, however, 20,000 or even 30,000 have been posted on the board. The responsibility for estimating the sales devolves upon an official of the Association, who between 10 and 11 o'clock makes inquiries among the selling and buying brokers as to the probable turnover for the day, and any sales made after 2-30 the previous day. At 11 o'clock the figures (say 10,000) are posted. They may include 7,000 for the current day and 3,000 sold late the previous day. If any sales are made between 11 o'clock and 2-30 p.m., the figures are increased accordingly. The sales are not increased after 2-30 o'clock. At 2-30 p.m. (Saturday 12-0) the sales are sub-divided as follows:—

Spot Sales 8,000, including Speculation and Export 1,000. Or: Spot Sales 10,000, including Spec. and Export 1,000 and 2,000 sold to the trade late yesterday.

Every Friday before 3 o'clock (except when holidays intervene) each firm is *compelled* to deliver to the Association a complete return of "Sales or Forwarded" under the headings provided, and a fine is imposed for late delivery of the form. The returns are tabulated, and the details of "Forwarded" to the trade, "Exported," and "Stocks," are posted on a board in the room at about 3-30 p.m. The remainder of the returns is published on Saturday mornings, with the comparison of actual and estimated sales of the week.

Cotton Sold "on Call."

If cotton is sold on Spot terms "on call," the call must be made not later than 30 days after the invoice date.

If cotton is sold on C.I.F. terms,

(*a*) For shipment, the call must be made not later than 24 hours after the declaration of marks and the ships' names.

(*b*) For guaranteed arrival (or delivery), the call must be made not later than 24 hours after arrival or delivery.

If cotton is sold to be called during any month without any particular date being stipulated for the call, such cotton must be called before the noon of the last business day but one of the month; in default thereof the price shall be fixed on the basis of the official midday value of the said last business day but one. If cotton is sold to be called on or before a certain date, it must be called before noon of that date. In default thereof, the official midday value of that day shall form the basis of price; but if the last day of call is also the last day of the particular month upon which the price has to be fixed, then the price for the uncalled cotton shall be fixed by arbitration—on the basis of not less than 2 points and not more than 12 points over the official closing value of that outgoing month.

Cotton sold "on Call" must be called in one lot, or in lots of not less than 100 bales—unless otherwise stipulated at the time of sale, or agreed to later by the seller.

"Spec. and Export."

Cotton bought by one Liverpool house from another for resale on the market is called "Speculation," but if for export it is classed "Export." Transactions under these headings are returned by the respective buyers.

Recount of Stocks.

Twice yearly, at the end of July and of January, members are compelled to return all the stock they hold, and at the end of October and April a supplementary recount of stocks other than American takes place, and any differences between the estimates and actual figures existing on the same day are adjusted by the Liverpool Cotton Association, and form the basis of future statistics.

"Spot" Prices.

The prices of "Spot Cotton" are fixed daily at 12-15 p.m. (Saturday 12-0, excepting when Saturday falls upon the last day of the month, then 12-15) by the Com-

mittees appointed for the various growths. As a rule the price of American Middling is altered to harmonise with the difference in Futures, between 12-15 p.m. each day, other growths being in sympathy with American, excepting Egyptian, in which the alteration of the prices is controlled by the fluctuations of its own Futures market.

The Clearing House.

The Clearing House (entirely under the control of the Liverpool Cotton Association, Limited) plays a very important part in the daily routine of the Liverpool market. All payments for Spot cotton, claims, etc., and all differences upon Futures contracts, are cleared through the medium of the Clearing House. All moneys or differences are paid by the broker into the Bank of England. Returns are made to the Clearing House by the parties interested, and when balanced by them the broker who is entitled to claim his balance makes an application to the Bank of England, which immediately meets his request.

There are a few side issues regarding the technicalities of Docket Cotton, but as they are more in sympathy with "Futures" they have no real bearing on the customs or regulations of the Spot business. We have therefore now described the movement of a bale of cotton from the time of its importation to its arrival at the mill, when it passes beyond the province of the Cotton Association.

The "Futures" Market.

Earlier in these pages reference was made to the "**Cover**" with "Futures" of a sale or purchase of Spot Cotton The "Futures" market is the "Insurance" Department of the Liverpool Cotton Association, governed by its stringent rules and bye-laws. Without its facilities the importing and reselling of actual cotton would be attended with grave risks, in fact, would be impossible from a merchanting point of view. For the working of the Futures Market we cannot do better than refer our readers to the exposition on pp. 21-37 of "Cotton Futures: What they Are, and How they Work in Practice"—by Mr. Charles Stewart, of 1, Cotton Exchange Buildings, Liverpool.

The Rules and By-Laws of the Liverpool Cotton Association, Ltd., containing all resolutions and amendments

up to date, can now be purchased. The price is 3s., and copies may be obtained through any broker of the Association.

NET WEIGHT COTTON CONTRACT:

Purchasing by Net Weight.

At the fifth Congress of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, held in Paris in June, 1908, the following important resolution was passed:—

> That this meeting, having heard the report of the Cotton Contract Commission, instructs such Commission to place before the European Cotton Exchanges the form of the c.i.f. contract on a net weight basis without franchise; and as soon as such form is accepted by the Exchanges, strongly advises the trade to use the contract form.

This new "Net Weight Contract" was duly accepted by the Liverpool Cotton Association. The Net Contract binds the seller to an agreement that the cotton shall be charged net weight, so that the bands for covering the bale do not enter into the bargain. Heretofore (and still, of course, under the old contract) of the cotton purchased from American sources, 6 per cent. of the gross weight consists of tare, which is paid for as cotton. For instance, in a bale of 500 lb. the weight of canvas and bands is at least 22½ lb. This means that 50,000 lb. actual gross weight may be invoiced to the buyer as 50,500 lb. And if the cotton loses weight during transit, the buyer is required to pay for the 50,500 lb. as invoiced, and can only claim for any loss that reduces the total weight of the cotton below the actual 50,000 lb.

Under the new system cotton is bought by weight and not by bale. For instance, instead of purchasing 100 bales, the buyer purchases 50,000 lb. net weight; and the seller has not the right to tender 5 per cent. more or less, at the contract price, but only 1 per cent. Should this 1 per cent. be exceeded either way, the difference would be settled between seller and buyer on the last day of landing.

The "Cotton Season" in Liverpool in future will end on July 31, when all the figures will be totalled, giving the imports and exports, the sales, deliveries to spinners, and the stock. Until 1914, the American Cotton Season ended on 31st August.

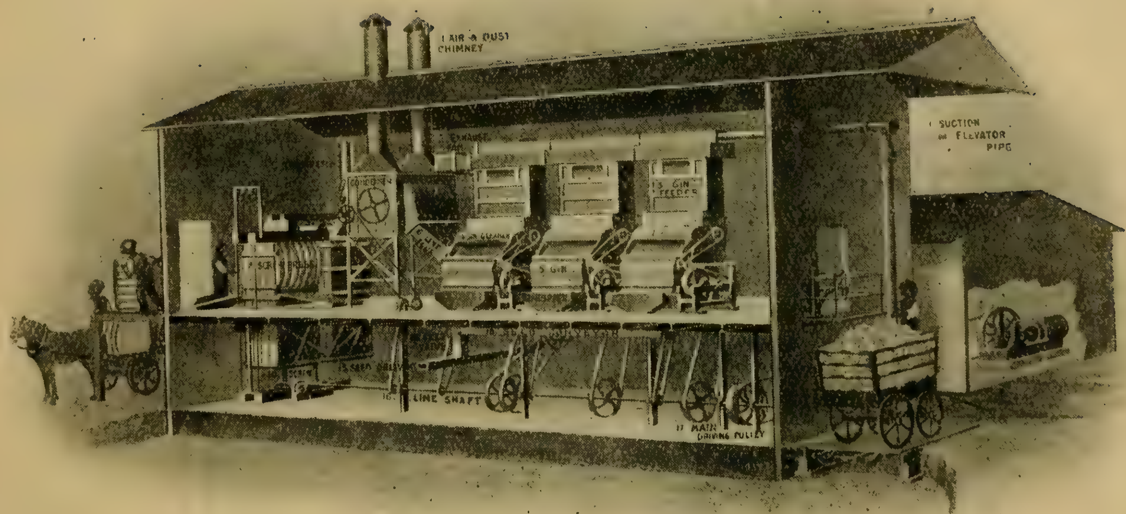
SECTION II:

OPENING, SCUTCHING

CARDING

COMBING, DRAWING

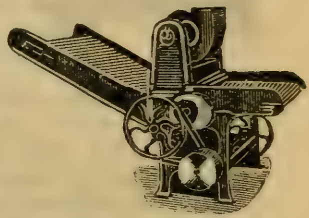
ETC.



A Modern Cotton Ginnery.
(by permission).

GINNING, OPENING, AND SCUTCHING MACHINERY

SEED COTTON OPENER.



Function. — To disentangle seed cotton, which is more or less matted together by the interlacing of the fibres, thus preparing it for the gin, and thereby increasing the production of the ginning plant.

Description. — Is usually made with a cylinder 40 inches wide, and feed and delivery lattices. A fan for taking away the dirt is placed above the cylinder, and is connected with an uptake pipe.

Pulleys.—12 in. dia. × $2\frac{1}{2}$ inches.

Speed.—320 revs. per min. **Power.**—2 I.H.P.

Production.—1 machine to 10 Macarthy gins.
1 machine to 5 double roller gins.

Floor Space.—With lattice, 8 ft. 3 in. × 5 ft. $7\frac{1}{2}$ in.
Without do., 3 ft. 96 in. × 5 ft. $7\frac{1}{2}$ in.

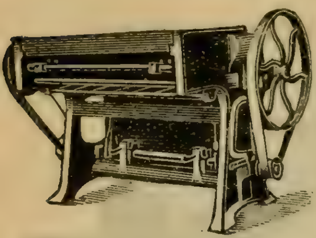
COTTON GINNING.

The principal designers and builders of cotton ginning machinery have introduced a system of continuity, in which there is practically no handling of the material between lifting the seed-cotton from the grower's cart to loading the compressed bale for shipment. The whole is worked on the pneumatic principle, and may be dependent on either gas or oil engines, according to circumstances.

Complete Installation of Three Saw Gins, each containing 70 saws:—

Suction Elevator Pipe.	Double Box Screw Press.
Exhaust Fan.	Tramper. Screw.
Gin Feeder.	Air and Dust Chimneys.
Gin Cleaner Feeder.	Cotton Seed Hoppers.
Gins.	,, ,, Conveyor.
Lint Flue.	,, ,, Valve.
Condenser.	,, ,, Delivery.

The productive capacity of this installation may be increased by the addition of an opener for disentangling the seed-cotton before it passes into the gins. A machine for this purpose is described above.



COTTON GINS

Function.—Removes the seeds and husks from the cotton, preparatory to the latter being made up into bales for transit.

Types.—There are several, but the most universally adopted are the "Macarthy" (or roller) gin, and the "Eagle" (or saw) gin.

Application.—The "Macarthy" gin is used for both long and short staple cotton, and is peculiarly adapted for dealing with cotton that offers difficulty in the separation of the fibres from the seeds, which often happens with such as is grown in Asia. The Eagle gin is adapted principally to short-staple cotton.

Driving.—Both types of gin may be driven by hand or other power. The latter is often obtained by the use of horses, mules, or oxen, walking over a circular track and operating suitable gearing.

Description.—The Roller or Macarthy Gins, which are usually about 40 inches wide, consist of a roller covered with leather washers, or a wooden roller covered with leather, against which is pressed a "doctor" or knife blade. They are self-feeding: that is, the cotton is merely thrown into a hopper, whence it is drawn by friction between the leather roller and the doctor-knife. The cotton is then operated upon by a reciprocating beater-knife, which strikes the seed and separates it from the cotton, the seed falling through a grid provided for the purpose. The cotton is fed to the roller by the action of an automatic feeder, having a reciprocating motion. The gins are made either single-acting or double-acting, the difference between the two being that the latter is provided with two beater-knives, which are reciprocated at equal speeds, but so arranged as to rise and fall alternately.

The Saw, or Eagle, Gin is usually made with 60 to 70 saws, arranged on bars in sections of five saws each. The cotton, on entering the machine, encounters the teeth of the saws as they revolve, and is carried round by them until the seeds to which the cotton fibre is adherent come into contact with the parallel bars of the gin, whereupon the saws strip the fibres from the seeds. The fibre is then removed from the saws by a revolving brush, the surface speed of which is sufficient to create

a current of air, which throws the cotton along a trunk to a condenser. The object of the latter is to form the cotton into a fleece, which is deposited into any suitable receptacle. As the seeds are removed, they pass down a chute on the opposite side of the machine.

Speeds.—Macarthy gin, single, 700 to 800 revs. per min.; ditto, double, 550 to 600 revs. per min.; Saw ditto, 250 to 350 revs. per min.

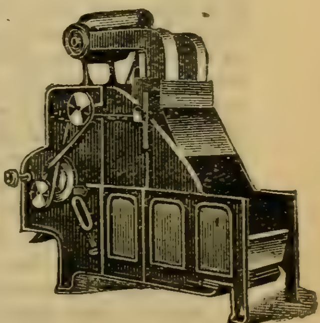
Pulleys.—Macarthy gin, 6 in. to 7 in. dia.
Saw ditto, 10 saws, 9 in. dia. × 3 in. wide.

Power.—Macarthy gin, $1\frac{1}{4}$ I.H.P.
Saw ditto, 10 saws, 1 I.H.P.

Production. — Macarthy gin, single-acting, when dealing with clean, long-staple cotton, such as Egyptian, Sea Island, etc., 30 to 60 lb. per hour; ditto, ditto, dealing with such as Surat, Surinam, and similar cottons, 45 lb. per hour; Saw gin, 10 saws, 45 lb. per hour.

Floor Space.—Macarthy gin, 5 ft. 0 in. × 3 ft. 5 in.
Saw gin, 70 saws, 6 ft. 6 in. × 7 ft. 2 in.

BALE BREAKERS.



Function.—Disintegrates the cotton, partially cleans it, prepares it for mixing with other varieties, or for feeding direct to openers when mixing is not adopted.

Types.—There are three recognised types—namely, the spiked roller machine, the porcupine breaker, and the hopper bale breaker. The first two are now almost entirely discarded in favour of the hopper type.

Description.—The hopper bale opener has a horizontal lattice for receiving the cotton and conveying it to a vertical lattice provided with strong steel teeth. The latter is in turn stripped of the superfluous cotton by an "evener roller" having receding teeth. The cotton that is allowed to go forward is taken off by a flap roller, and falls upon a grid or other kind of grating, through which any loose dirt falls away. The cleaning properties of this machine are assisted by the application of a fan arrangement, which takes off any foreign matter and conveys it through trunks to a suitable dust chamber or to the outside of the mill.

Feeding.—These machines are sometimes fed by a slow travelling lattice, carried just above the floor. This arrangement admits of a great amount of cotton being placed on the lattice and left by the attendant, who can then turn his attention to the mixings.

Another method, which is in great favour among spinners, is to provide at the back of the hopper a series of slanting grid-bars, with the top part loose and hinged to allow of a great amount of cotton being placed in the hopper. The grid allows the loose dirt to fall through, and the angle of the bars is such that the cotton beaten from the upright lattice can fall loosely to the bottom, ready to be taken up again with the fresh supply, until it is so fleecy that it can easily pass forward. The cotton in the hopper is thus constantly under agitation, and much dirt and dust is by this means removed.

Application.—The machines are mostly connected to mixing lattices, in which cases any moisture in the cotton is allowed to evaporate. They may also be coupled up to the vertical or exhaust openers direct, or to automatic reversing lattices feeding two hopper feeders supplying vertical openers, when mixings are not required. Sometimes in small mills these bale breakers are made to feed directly into a range of machines consisting of an automatic feeder, an opener, and a scutcher, all coupled together. The delivery of the cotton is made directly to the auto-feeder by means of a short lattice, and the feed is regulated by the automatic feeder, which is provided with a motion for stopping and starting the bale opener, according to the amount of cotton contained in the box or receiver of the automatic feeder. By this means a regular supply of cotton is assured, and even laps are obtained from the scutcher with very little attention.

Speed.—450 revs. per min.

Pulley.—16 in. dia. × 3 in. wide. **Power.**—2 I.H.P.

Floor Space.—A 48 in. machine, 9 ft. × 6 ft. 6 in.

Production.—

A 48 in. machine, Egyptian cotton, 750 lb. in 10 mins.

Ditto, American cotton..........500 lb. in 6 to 10 mins.

Combined Wood-and-Steel Lattice.—Facilitates the combing action of the inclined lattice, and reduces the detrimental effect of the rolling movement to which the surplus cotton is subjected when returning to the hopper.

The spiked lags are made of sheet metal lined with wood. Each spiked lag is interspersed with two plain

ones, also of metal and mounted on wooden foundations, but at slightly inclined angles. The spikes, which are stout, are shaped with pencil points, and are a considerable distance apart. The lags are secured to leather bands by clips. The spikes are almost, but not quite, parallel with the leather bands.

THE MIXING AND BLENDING OF COTTONS.

MIXING.—The cotton usually passes from a bale breaker to a "mixing" or stack. It is conveyed by mixing lattices, which deposit it upon any one of a number of mixings. The direction of the lattices is controlled by an arrangement of levers or chains, operated from one front.

The cotton is built up into a stack in HORIZONTAL layers; but in feeding from the stack to the opener it is taken in VERTICAL sections, in order that a thorough mixing shall take place. The objects of mixing are :—

(1) To average the variations in the cotton, which are to be found even in bales of the same quality and mark. By building up the stack horizontally and feeding it vertically, some portions of each bale in the stack are fed together. This makes for regularity in the yarn.

(2) To allow the atmosphere to open the cotton. When the cotton leaves the bale it is in hard matted cakes, which even the bale breaker cannot altogether open without damage. Especially in the case of the longer and better-class cottons is it desirable that the opening should be done without too much severe mechanical treatment. When cotton lies in a stack there occurs a natural falling apart of the fibres, which helps greatly in the subsequent cleaning.

(3) To facilitate the blending of cottons. Where blending of different classes of cotton is carried out, it is a great advantage to have a large stack, as this guarantees that the different cottons shall be evenly distributed throughout the mixture.

(4) To facilitate the feeding of the opener. The mixing stack provides a stock always ready for feeding, and thus avoids the serious interference with production that would take place whenever any little accident stopped the bale breaker or lattices.

BLENDING.—Yarns are commonly made from a blend of various cottons, and blending is a work requiring much skill and experience. By the successful blending of a number of cottons a yarn may often be produced possessing characteristics that could not be obtained from any one of the cottons used alone. On the other hand, by endeavouring to blend together unsuitable cottons much damage may be done to the quality of the yarn. It may be laid down as a general rule that cottons should not be blended that—(*a*) Differ greatly in length of staple. (*b*) Differ greatly in feel of fibre : *i.e.*, rough and smooth cottons. (*c*) Differ greatly in colour.

Blending is not always carried out in the Mixing Room : it is sometimes done in the Blowing Room, and sometimes at the Draw Frame. If, for instance, two cottons are to be blended that differ greatly in cleanliness, but are in other respects similar, it may be found desirable to pass them separately through the opener, giving one more beating than the other and extracting more dirt therefrom. In such a case the blending would be at the Scutcher, by feeding together laps from the two cottons. Or, if two cottons are to be blended, one of which is more "neppy" than the other, it may be desirable to card them separately, and blend them at the Draw Frame, by feeding together so many ends from each cotton in the desired proportion. Also, when one cotton is to be carded only, and the other combed, it is necessary to blend them at the Draw Frame.

Much experience in the blending of cottons may be gained by passing small samples of various blends through the mill, carefully examining them, and making records at the various machines. In this way the strength, waste, and general appearance of the roving and yarn, may be taken as reliable indications of whether the blend has been satisfactory or otherwise.

ROVING WASTE OPENER.

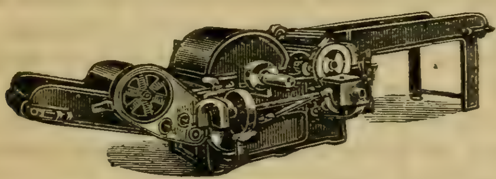
Function.—Cleans and opens roving and "clearer" waste, and prepares it for mixing with the cotton coming from the bale opener. By thus mixing with the good cotton a considerable saving is effected in the raw material.

Types.—Various, according to the designs of the respective makers :—

(1) In which the waste to be opened is fed to the machine on an ordinary travelling lattice. It is then

drawn by a pair of feed rollers to a small cylinder covered with wire clothing. The surface speed of the cylinder is much greater than that of the feed rollers; and as it revolves the teeth of the clothing catch the cotton in such a manner as to cause it to be carried round in short lengths. The material is then transferred from the small cylinder to a large cylinder by the aid of a knife-edge guide-plate. It is then opened, the twist is taken out, and it is delivered in a loose state in various ways to suit the requirements of the blowing-room.

(2) In which the small cylinder is dispensed with, and the material from the travelling lattice is passed between a saw-toothed fluted roller and a series of dead-weighted "dog" levers, which direct the waste to the



spiked cylinder. From the latter the opened cotton is thrown by centrifugal force on to a perforated cage, 12 inches diameter, whence it is delivered in the manner required, usually by a lattice slightly inclined to deliver into skips or on to a travelling lattice.

Application.—The machines can be adapted to work in conjunction with any installation of blowing-room machinery. They are usually placed in close proximity to the bale breaker or opener, and are made to deliver as follows:—

Into a "skip" (skep) or movable box.

With mouthpiece for coupling up to a trunk for connecting to the delivery side of a "Crighton" opener, or into an exhaust tube for openers, or on to a lattice going to the mixings, or into an hopper feeder.

Speed.—700 revs. per min.

Pulley.—10 in. dia. × 3½ in. wide.

Production.—600 lb. in 10 hours.

Power.—3 to 4 I.H.P.

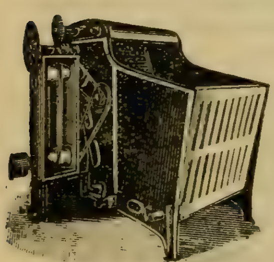
Floor Space.—9 ft. 7 in. × 5 ft. 6 in.

Hopper Feeder.—Works in conjunction with the Roving Waste Opener. It loosens the material, prevents over-feeding, and reduces the risk of hard substances entering the opener. This differs somewhat from the ordinary feeder, inasmuch as it is provided with an oscillating comb at the feed side, and a stripping comb at the delivery side of the upright lattice. To this latter an elliptical or raking movement is imparted. Any long strands of rove not sufficiently detached by this raking action of the comb are fed back into the spiked lattice by a revolving clearer shaft, which works just beneath the comb.

HOPPER FEEDER.

Function.—(1) Feeds automatically an even weight of cotton to creeper feed tables, direct to Crighton openers, or on to the lattices of large cylinder openers or scutchers. (2) Slightly opens the cotton and thus makes the next process more effective. (3) Cleans the cotton. (4) Obviates risk of fire, as heavy objects cannot pass through. (5) Ensures uniform laps.

Description.—Usually made with a capacious hopper, into which the loose cotton is deposited. The material is carried upwards by a spiked lattice, and is discharged (on the opposite side) upon the lattice creeper connected with the first opener or direct into the opener itself through a 9-inch pipe. The amount of cotton allowed to go forward is regulated by a spiked roller, which is made adjustable to the face of the upright lattice The distance between the face of the lattice and the roller thereby regulates the thickness of fleece allowed



to go forward. The roller, by revolving in the opposite direction, strips off the superfluous cotton, and causes it to fall back into the hopper chamber. The makers provide an arrangement for regulating the delivery of the cotton to the machine, in order to ensure a uniform volume or weight of material passing against the upright lattice. This may be effected by lattice creepers delivering the cotton according to the requirements of the hopper. When the mixing room is overhead, the cotton may be deli-

vered into a tube or pipe, provided with either a spider or a shaft having blades or flaps, or with a weighted door placed near the lower end. As the working reduces the weight of cotton in the hopper, the spider revolves (or the door opens) and allows more cotton to go forward.

Immediately the required amount has been allowed to enter the machine, the supply ceases automatically. One way of effecting this object is to apply a hinged door or series of bars about midway in the hopper, which press upon the cotton and are deflected according to the amount the hopper contains. Another way is to provide a separate receptacle for the cotton. This is placed inside the hopper, which rises and falls according to the weight of cotton contained therein. A third way is to attain the object through the bottom or upright lattice of the machine, which is arranged to indicate the weight; and a fourth is by making the back of the hopper movable and sensitive to any variation in the volume of cotton in the hopper. All these devices are connected with the feeding lattices, the working of which they control according to circumstances.

Another device for perfect feeding is a box at the delivery end, under the upright lattice. This box is so arranged that the outlet can be altered to allow of any thickness of web to be delivered. This is done by means of a sliding or adjustable door being opened or closed, as the case may be. When too much cotton is delivered into the box, the surplus cotton is taken off by a revolving wiper placed above the box, and is put on to the under side of the lattice, whence it is carried back again into the receiver of the hopper. By this means a uniform weight of cotton is constantly in the box, and a uniform delivery is assured.

Delivery.—To ensure uniformity in delivery, the cotton may be passed through a pair of rollers and a pedal regulator, worked on the cone principle. This regulates the speed of the upright lattice according to the thickness of the web or fleece being delivered.

Speeds.—Stripper roller, 225 revs. per minute; evener ditto, 100 revs. per min.; upright lattice (surface speed), 60 ft. per min., according to weight of lap required.

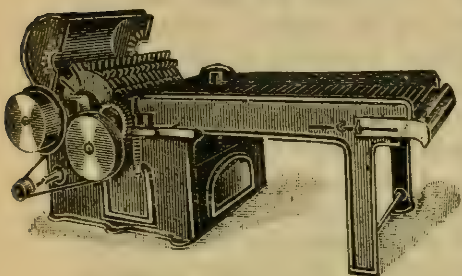
Pulley.—12 in. dia $\times 2\frac{1}{2}$ in. wide. **Power.**—$1\frac{1}{2}$ I.H.P.

Production.—According to requirements of opener.

Floor Space.—8 ft. $\times$ 6 ft.

PORCUPINE OPENER OR CREEPER FEED TABLE.

Function.—Is not only employed as a feeder to openers, but serves as a preliminary cleaning and opening machine for the cotton. From this machine the cotton enters the opener in a loose, fleecy condition. These machines are only employed when treating American and Indian cottons, and are generally used as an alternative to hopper feeders.



Note.—In some modern mills automatic feeders are used in place of the creeper feed, the users being of opinion that the former loosen the cotton equally as well, and with less injury to the staple.

Description.—The machines are provided with a long lattice creeper, usually 3 ft. wide, which delivers the cotton between two pairs of coarsely fluted rollers with a pedal arrangement attached. From these rollers the cotton encounters the porcupine cylinder, which is built up of a number of discs, each having steel reversible teeth arranged to project in helical lines round the cylinder. As the cylinder revolves, the teeth thereon strike the cotton from the rollers and throw it on to a grid composed of a number of bars, which surround the cylinder. Through this grid the dust and other foreign matter are discharged, and the cleaned cotton goes forward.

In place of the rollers and pedals, two pairs of coarsely-fluted rollers only may be used, in which case heavy weights or springs are employed to keep the rollers in action.

Speed.—800 to 1,000 revs. per min., according to dia. of cylinder. **Pulley.**—20 in. dia. **Power.**—$1\frac{1}{2}$ I.H.P.

Production.—30,000 to 40,000 lb. per week.

DUST TRUNKS.

Function.—Are admirably adapted for dealing with dirty cotton. They are usually placed between the porcupine or hopper feeder and the vertical or exhaust opener; they are intended to get rid of much heavy dirt, sand, etc., from the cotton.

Description.—The trunk is built up of a number of bars or ribs placed transversely across the tube, with spaces between each for the dirt to fall through. Below the bars provision is made for collecting and removing the dust deposited. The cotton operated upon is drawn over the bars by the action of the fan in the opener.

The system may be augmented by the application of a travelling apron underneath the bars, working in the direction opposite to the passage of the cotton, upon which the dirt falls and is carried away. The trunks are connected with the feeders and openers respectively by means of 10 in. galvanised iron piping.

Pneumatic Handling of Cotton.—Is an extended adaptation of the trunk system, and takes the place of open lattices in conveying cotton from the bale breaker to the mixing stacks, and thence to the blowing-room machinery.

Fixed in the piping over each mixing-stack is a delivery box, provided with a perforated cage and stripping and delivery rollers; and in the mouth of the return piping near the bale breaker there is an exhaust fan. As the opened cotton leaves the bale breaker, it is drawn by the fan to the respective delivery boxes, and is allowed to fall therefrom on to the mixing-stacks. For controlling the supply of cotton to each stack, the boxes are provided with valve mechanism, which may be operated from one common centre. As the cotton encounters the cages in the delivery boxes it is relieved of much of the dust and dirt it contained, which is carried away by the fan mentioned.

OPENERS.

Function.—Opens out and loosens the fibres of the cotton, and at the same time removes therefrom a good portion of the dirt and grit it contained. The cotton is thus prepared for the subsequent process of scutching.

Types.—(1) Those with porcupine beaters working vertically—known as "Crighton openers."

(2) Those with porcupine beaters working longitudinally.

(3) Large cylinder openers known as the "Buckley" type.

(4) Exhaust openers, in which fans are placed on either side of a small porcupine beater, all working horizontally with the machine.

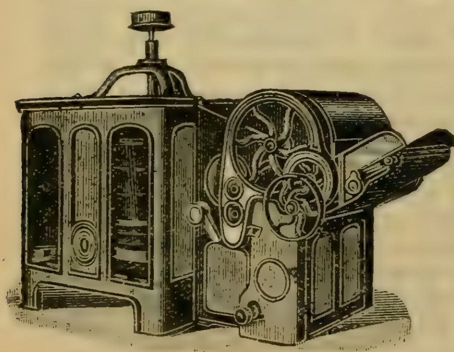
Feeding. — In several ways, according to circumstances, but chiefly by hopper feeder, porcupine, through exhaust trunks, or direct from the bale breaker.

Delivery.—The machines are sometimes coupled up with one or two scutcher beaters, in which case they deliver the cotton in the form of laps for feeding up and doubling at the intermediate or finishing scutcher.

Opener with Vertical Beater.

Adaptability. — Has a high productive capacity, and is specially adapted for lower grades of cotton, on account of its excellent cleaning properties.

Feeding.—Generally by lattice or by hopper feeder through a small porcupine feeder, which delivers the loose cotton at the foot of the vertical beater. It is gradually worked up to the top or largest disc, and afterwards passes through cages on to the delivery lattices (if single openers); or to the two or three-bladed beater, through the cages and the lapping-up apparatus (if these are so combined for making laps).



The machines are sometimes made with two vertical beaters arranged to work separately or together, and may be coupled up to one or two scutcher beaters and lap forming apparatus. The double vertical opener is mostly used for Indian, very hard-pressed, and dirty cottons.

Of late years a number of dirty bales have come through with what had previously been fairly clean

cotton, and it has become a common practice of some mills to put the cotton through a bale opener and feed directly into a vertical opener, and then on to the mixings. By this means any dirty cotton coming through is thoroughly cleaned and the staple not injured in the slightest.

Speed.—Beater, 1,000 revs. per min.

Pulley.—12 to 14 in. dia. × 4 in. wide.

Scutcher beater, 2 blades, 1,500 revs.
 ,, ,, 3 ,, 1,000 ,,
 ,, ,, pulley 10 in. to 15 in. dia.

Power.—Single beater machine, 4 I.H.P.
 Double ditto........8 I.H.P.

Production.—40,000 lb. per 56½ hours if without lap apparatus.
 Or, 30,000 ,, ,, ,, if with lap apparatus.

Floor Space.—
 Single machine, 10 ft. 6 in. by 5 ft. 6 in.
 Double ditto, 16 ft. 6 in. by 5 ft. 6 in.

If with hopper feeder and porcupine, add 13 ft. to length and 1 ft. 2 in. to width. If with lattice feed and porcupine, add 10 ft. 9 in. to length and 1 ft. 2 in. to width. If coupled with single scutcher and lap apparatus for 38 in. laps, add 8 ft. 10 in. to length and 1 ft. 4 in. to width.

Opener with Porcupine Beaters working longitudinally.

Adaptability. — Generally used for the same classes of cotton as the opener with porcupine cylinder arranged transversely. Is also usually made with one or two beaters and a lap-forming apparatus.

Feeding. — Usually by hopper feeder, porcupine opener, or exhaust trunks.

Speeds.—450 to 500 revs. per min.

Pulleys.—16 in. dia.

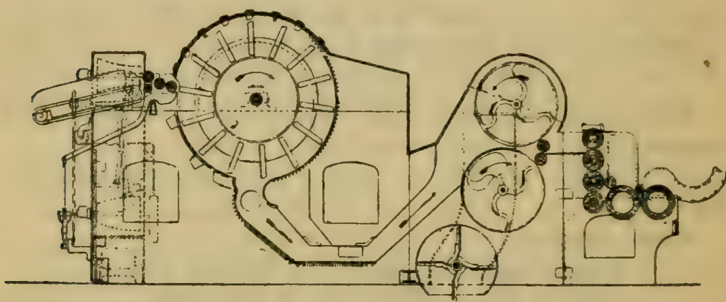
Power.—5 to 6 I.H.P.

Production.—30,000 lb. per 56½ hours.

Floor Space.—38 in. machine, 19 ft. 3 in. × 6 ft. 2 in.

Large Cylinder Opener, known as the "Buckley" Type.

Adaptability.—Suited for the treatment of medium and higher grades of cotton. For "Sea Island" cotton it is usually made with one cylinder of 36 in. to 41 in. diameter, combined with a lap-forming apparatus; for Egyptian and the better classes of American it is made with one cylinder, of 36 in. to 41 in. diameter, and one beater 16 in. to 18 in. diameter, combined with a lap-forming



apparatus, and one beater. When these machines are used to work dirty American cotton, or even some classes of Indian cottons, they are made with two large cylinders and two beaters, with the usual lapping-up apparatus. The laps from this machine are sometimes taken directly to the card without passing through a single scutcher when working the highest grades of cotton, the contention being that too much beating weakens the long-staple cottons.

Feeding.—By lattice or hopper feeder. Are sometimes made with a feeding lattice, which delivers the cotton through pedal feed rollers on to a large cylinder (built up of discs to which are secured hardened steel plates or teeth). The cylinder is cased in with plates of cast-iron, and on the under side are projections or teeth, which arrest the progress of the cotton and thus assist the cylinder in opening the fibres. Next the cotton passes over dust bars underneath the cylinder, and then through cages to the lapping-up apparatus. Or,

when coupled to a scutcher part—after leaving the cages it passes through two pairs of rollers, through the beater, then through cages, on to the lapping-up apparatus.

Speeds.—Cylinder, 450 revs. per min. for American; beater pulley, 12 in. dia. × 4½ in. wide; lap apparatus pulley, 24 in. dia.

Pulleys. — Cylinder pulley, 20 in. dia. × 5½ in. wide; beater pulley, 12 in. dia. by 4½ in. wide; lap apparatus pulley, 24 in. dia.

Power.—Single machine, 5 I.H.P.; double ditto, 10 I.H.P.

Production.—9,000 to 15,000 lb. per 56½ hours.

Floor Space.—

Single machine for 38 in. laps, 18 ft. by 6 ft. 9 in.
Double ditto ....20 ft. 6 in. by 6 ft. 9 in.
If with hopper feeder, add 4 ft. 8 in. to length.

By the application of a patented form of grid the cleaning power of this type of opener has been greatly increased and its application extended, while in some instances the system is applied as first and second opener to produce laps for the cards directly, without the use of a scutcher beater. This circular grid commences directly over the centre of the cylinder, and extends a short distance along the under side, thus encircling more than half its circumference. This addition admits of fully two-fifths more cleaning bars to the cylinder's surface. On the same basis, the cleaning properties of the machine have been augmented, by increasing the number of horizontal bars over which the cotton passes to the cages.

Exhaust Opener with Porcupine Cylinder arranged with Fans on either side.

Adaptability.—Same as machine on preceding page. It is usually provided with one or two beaters (according to the class of cotton being worked) and lap-forming apparatus.

Feeding.—By hopper feeder, porcupine, and trunks. Or by lattice, porcupine, or trunks. The cotton is drawn through a pipe from the hopper or porcupine feeder to the cylinder by means of an exhaust fan placed in line with the cylinder, from which it passes through a pair of cages to rollers, and is taken off by a bladed beater. The

cotton is then passed through cages to calender rollers before being formed into a lap.

Speeds.—Cylinder, 900 to 1,000 revs. per min.; beater, 1,200 revs. per min.

Pulleys.—Cylinder, 13 in. dia.; beater, 12 in. dia.

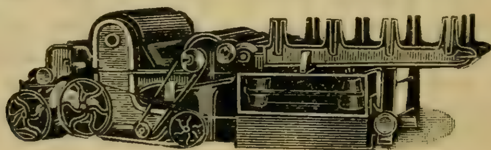
Power.—8 to 9 I.H.P.

Production.—25,000 to 30,000 lb. per 56½ hours.

Floor Space. — If with beater and lap-forming apparatus, 38 in. wide, 16 ft. 6 in. × 7 ft. 3 in.

SCUTCHER.

Function.—Cleans the cotton, and forms same into laps of uniform weight and density ready for putting up at the carding engine. Is made with one or two beaters, according to circumstances, and has lap-forming apparatus attached.



Feeding.—When a Crighton opener only is used previous to this machine, and the cotton is in a loose state, it is fed by an automatic feeder, and produces breaker laps. These are afterwards put on a lattice, a doubling of four laps being usual when used as a finisher scutcher. The material passes between rollers having pedal motion, on to the beater (which is made up of two, three, or four blades); through a pair of cages, then between three or four pressing rollers and made into a lap. These pressing rollers consolidate the laps, and prevent them from "licking" when being unrolled afterwards at the carding engine.

Speeds.—

Beater,	with 2	blades,	1,200 to	1,500	revs.	per min.
,,	,, 3	,,	900 ,,	1,000	,,	,,
,,	,, 4	,,	700 ,,	850	,,	,,

Four-bladed beaters are sometimes used for the first beaters in double scutchers. These beaters are generally made with two flat blades and two with porcupine teeth.

Pulleys.—10 in. to 12 in. dia. × 4½ in. wide.

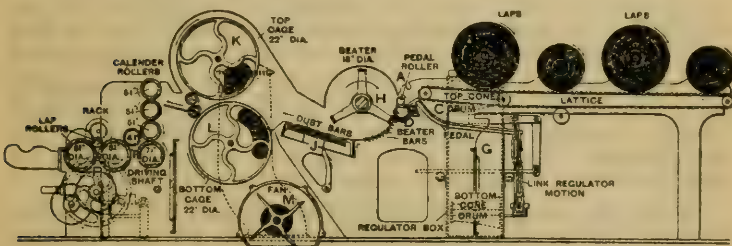
Power.—Single beater machine, 3 to 4 I.H.P.; double ditto, 6 to 8 I.H.P.

Production.—About 10,000 to 15,000 lb. per $56\frac{1}{2}$ hours, according to the weight per yard of the lap being produced.

American laps weigh 14 to 16 oz. per yard.
Egyptian laps weigh 10 to 11 oz. per yard.
Sea Islands laps weigh 9 to 10 oz. per yard.

Floor Space.—

Single machine for four 38 in. laps, 17 ft. × 6 ft. 6 in.
Double ditto, for four 38 in. laps, 22 ft. × 6 ft. 6 in.



SECTION OF SCUTCHER.

LAP Protector.—Dispenses with the dangerous practice of using the hands to guide the lap under the lap roller. Consists of a perforated metallic sheet mounted on hinges, which lifts according as the lap forms. When the end of the lap appears under the roller, the attendant puts into action a guide, which controls the entire width of the lap and compels it to go under the roller.

REMARKS.

For long-staple cotton the beater should strike off two feed-rollers, and for short-staple cotton from the pedal, as the latter allows the setting to be closer.

All beaters should be perfectly balanced, and "Mohler" or other specially oiled bearings be provided for the shafts to run in.

The grid-bars should have ample provision for adjustment to suit different classes of cotton.

Care should be taken that a good uniform draft is obtained. The ends of the cages should be air-tight, to ensure good selvedges.

The regulators should be kept clean and in good working order, so that their action may be sensitive and reliable.

Good work consists in making even laps of uniform weight per yard. Failure to do this will give more or less uneven working throughout the mill.

Uneven laps are sometimes caused (in the case of a breaker machine) by having too little cotton in the hopper. Or a grate-bar may project a little higher than its neighbour. Insufficient fan draft also will cause bad work.

Run the beaters according to the class of cotton being worked. Take care to get the required centrifugal force.

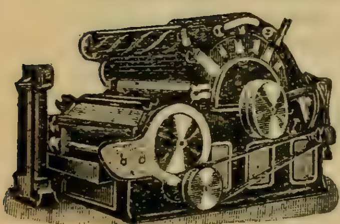
Be careful to set the feed-rollers in relation to the beater suitably for the work required.

Care must always be taken that the feed-rollers hold the cotton firmly. Also that the beater is close enough to the feed-roller, so that the cotton does not overlap, and in time close the space between the top of the grid bars and the rollers.

The cleaning properties of a scutcher may be increased by the introduction of a special rail, having sharp-pointed teeth inserted therein. This is fixed between the feed-rollers and the grid-bars. This rail also serves as a comb for laying the fibres of cotton in parallel order.

When the counter driving-shaft is attached to the machine framing, the fast and loose pulley should be on the line shaft with the strap-lever attached; the driving is then direct to the fast pulley of the machine, and the strap from the line shaft is stopped with the machine.

CARDING ENGINES



Function.—Arranges the fibres of the opened cotton approximately parallel, and removes therefrom the motes, bits of unripe seeds, neps, and all other impurities (including very short fibres and lint) from the surface of the seeds—really a system of combing—and delivers the cotton into cans in the form of sliver.

In the lap from the finishing scutcher there still remains a small quantity of leaf-seed, shell, sand, etc., and the fibres are also somewhat matted together. The object of the card is to remove these impurities, and to straighten out and place as parallel as possible the matted fibres—so that in the following processes the

cotton may draw better and be less liable to damage, when receiving the mechanical twist which finally converts the sliver into spun yarn. The carding engine is the last machine wherein the process of cleaning the cotton takes place, unless a comber be afterwards used. The length of time allowed for the cotton to pass through the machine depends upon the quality and cleanliness of the material under treatment, taking into consideration the final counts to be produced, the strength required, and for what purpose the yarn is to be used.

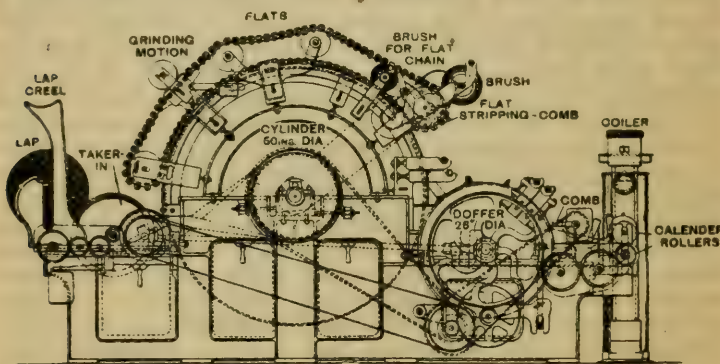
Description.—The laps from the scutcher are placed on a roller, which, by revolving, causes the lap to unwind. It is then gripped between a dish feeder or plate and a fluted feed-roller. The projecting end of the lap is then pulled through by the teeth of the taker-in, and (passing over mote knives and bars or grids) is laid on to the cylinder. The object of the mote knives is to take out a quantity of the heavier dirt. The cotton is carried forward on the surface of the wire with which the cylinder is covered, and brought into contact with similar wire on rollers or flats. As these latter travel very slowly and the cylinder revolves at a high surface speed, the cotton is combed between them, and is gradually carried towards the doffer (also covered with wire). The slow surface speed of the doffer strips the cotton from the cylinder, and the doffer in turn is stripped by an oscillating comb. The web from this comb is condensed into a sliver by passing through a trumpet and a pair of calender rollers and delivered through a coiler. It is afterwards coiled in layers into a card can.

Types.—(1) The Revolving Flat Card.
(2) The "Wellman" or Stationary Flat Card.
(3) The Roller and Clearer Card.
(4) The Combination or Union Card.

The Revolving Flat Carding Engine derives its name from the travelling "flats" or bars placed over the cylinder. These flats are covered with wire, and come into contact with the wire clothing of the cylinder. The flat ends are mounted on endless chains, which travel and carry the flats round a circular guide-plate or bend, which is easily adjustable to the surface of the cylinder. The flats travel slowly (from 1½ in. to 4 in. per min.) and in the same direction as the cylinder. The speed of the cylinder is 25,000 to 26,000 inches per min.; there is thus almost a stationary carding surface. The cotton is

practically pulled through the wire on the flats, cleaned of all dirt, etc., and laid more and more parallel. In turn it comes into contact with the doffer, by which it is stripped from the cylinder, and is then delivered to the coiler. The flats are cleaned by a comb in connection with a brush. The flats are ground while in their working position by means of a grinding roller carried from the card side or bend.

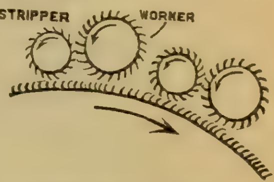
The Revolving Flat Carding Engine is the most widely adopted card, its productive capacity being higher, both in quality and quantity, than the other types. The "flat" system also admits of very fine setting, and a greater wire working surface for the cotton is available.



The "Wellman" Carding Engine differs from the above chiefly in the flats being stationary, and in the method of stripping the same. The flats are automatically raised up, turned over, stripped of waste, etc., by a stripping roller or a flat, then turned over again and restored to their original positions. This is effected by a toothed quadrant, which makes half a revolution, turning over one flat at a time. This done, it comes into contact with a reversing gear, and the flat (having been stripped) is again turned over and placed in its working position. A feature of this card is that the flats can be adjusted to almost anything—the flats at the feeding end of the card where the cotton contains most dirt can be set farther from the cylinder than those at the front, where it is advantageous to have them set as close as possible so as to comb the cotton.

By the same means it is ensured that the flats when turned over shall be placed in the exact position for

stripping and grinding, while in addition the flats can easily be set down as the wire on the cylinder wears. An arrangement is available whereby the first four or six flats at the feed end can—on account of the large accumulation of dirt that gathers there—be stripped three or four times against those at the delivery end only once. When the stripping-flat goes over the working one it takes the impurities with it; it is itself cleaned by a fixed stripping-flat, the dirt, etc., being deposited in a box at the front of the card. Many of these machines are in use in carding for the finer counts; but although the output is good the production, when compared with that of the revolving flat card, is small.



The Roller and Clearer Machine is used in carding waste and low-class cotton, because of its excellent cleaning properties. The rollers and clearers, which take the place of the flats in the other machines, are called "workers" and "strippers." The workers revolve slowly, in the direction opposite to the cylinder. Any long or tangled fibres that get upon the workers are stripped off by the rapid revolving strippers, and are put back again upon the cylinder surface. The wire of the workers points towards the back of the cylinder, while that of the strippers inclines in the same direction, as shown in sketch. The cylinder is stripped by a doffer, and is made into a sliver and delivered into cans through a coiler in the usual way.

The rollers and clearers are ground on a separate machine, and generally 4 rollers and 4 clearers are ground at the same time. Special arrangements are available to ensure the most perfect accuracy in the setting and grinding of these rollers.

The Union Card is a combination of the flat and the roller machines. It is provided with one or more workers and strippers next to the taker-in, and the remaining portion of the carding surface of the cylinder is covered with flats. By many spinners it was thought that to pass the cotton directly from the licker-in to the flats would result in filling the sliver with neps. Therefore the roller and clearers were used, their action being more gentle with the cotton; moreover, the rollers and clearers have great cleaning capacities, and the flats having a combing action, the combination of the two constitutes a notable feature of this card. Originally the flats were stationary, but of late years the revolving type have been used.

REVOLVING FLAT CARDS.

Feeding.—By laps from the finisher scutcher.

Pulley.—16 in. to 18 in. dia. × 3 in. wide.

Speeds, etc.

AMERICAN COTTON—

Feed roller, 2¼ in. dia., 1.1 rev. per min. Taker-in, 9 in. dia., 510 revs. per min. Cylinder, 50 in. dia., 170 revs. per min. Doffer, 24 in. dia., 15 revs. per min. Flats (110), 1 rev. in 1 hour and 10 mins.

EGYPTIAN COTTON—

Feed roller 2¼ in. dia., 1.1 rev. per min. Taker-in, 9½ in. dia., 420 revs. per min. Cylinder, 50 in. dia., 166 revs. per min. Doffer, 24 in. dia., 10 revs. per min. Flats (110), 1 rev. in 50 mins.

SEA ISLAND—

Feed roller, 2¼ in. dia., 1.1 rev. per min. Taker-in, 9½ in. dia., 340 revs. per min. Cylinder, 50 in. dia., 160 revs. per min. Doffer, 24 in. dia., 8.8 revs. per min. Flats (110), 1 rev. in 50 mins.

Although the doffers are given as 24 in. dia., they are sometimes made up to 27 in., with the speed varying in proportion.

Clothing.

AMERICAN COTTON—

Cylinder, 110's wire. Doffer, 130's wire. Flats, 120's wire.

EGYPTIAN COTTON—

Cylinder, 120's wire. Doffer, 130's wire. Flats, 120's to 130's.

SEA ISLAND—

Cylinder, 120's wire. Doffer, 130's wire. Flats, 130's wire.

Setting.

The setting for cards requires fine adjustment and careful attention to details. The gauges should be of standard sizes, usually 5/1000, 7/1000, 10/1000, or 15/1000. A common setting is given below, but conditions should govern all :—

Doffer and Cylinder set with 7/1000 gauge.

Top Flats (front) set to 7/1000. Top flats (back) set with 10/1000. These will be found to be close enough for practical purposes.

Licker-in and Feed Rollers are usually set the same as flats—10/1000.

Production.—

American, 560 to 900 lb. per 56½ hours.
Egyptian, 250 to 600 lb. ,, ,,
Sea Island, 140 to 250 lb. ,, ,,
Indian, 950 to 1,300 lb. ,, ,,

Floor Space.—For 38 in. laps, 10 ft. × 5 ft. 3 in.

Power.—For a machine with 50 in. cylinder, 24 in. doffer, 9 in. taker-in, and 105 flats. Width on wire 38 in.

Full card at work	.52 I.H.P.
With doffer stopped	.47 ,,
With flats and doffer stopped	.42 ,,

ROLLER AND CLEARER CARD.

Feeding.—By laps from the scutcher.

Pulley.—15 in. to 20 in. dia. × 3 in. wide.

Speeds, etc.—

Cylinder, 44 in. to 50 in. dia., 140 to 160 revs. per minute.
Doffer, 22 in. to 30 in. dia., 12 to 15 ,, ,,
Workers, 4 in. to 6 in. dia., 5½ to 7½ ,, ,,
Strippers, 3 in. to 3½ in. dia., 360 revs. per minute.
Taker-in, 8 in. to 9 in. dia., 270 ,, ,,

Taker-in covered with diamond-shaped saw-toothed wire.

Clothing.—90's for cylinder, 100's for doffer.
90's for workers, 100's for strippers.

Power.—For a roller and clearer card, 38 in. on wire.

Full card at work	.66 I.H.P.
With doffer and rollers stopped	.57 ,,

Width on Wire.—

For Indian cotton	45 to 48 inches.
For American cotton	38, 41, and 45 ,,
For Egyptian and Sea Island ditto	36 to 38 ,,

CARD CLOTHING.

The "counts" of card wire are based on the number of points or crowns covering 1 inch in length and 4 inches in width of fillet. Then always 10 crowns or 20 points to the inch longitudinally of the sheet. Thus—

Number of crowns per sq. inch ÷ 2.5 = counts.
,, counts × 2.5 = crowns per sq. inch.
,, crowns × 5 = points per sq. inch.
,, counts × 720 = points per sq. foot.

Counts of wire.	Crowns per sq. inch.	Points per sq. inch.	Crowns per sq. foot.	Points per sq. foot.
60's	150	300	21,600	43,200
70's	175	350	25,200	50,400
80's	200	400	28,800	57,600
90's	225	450	32,400	64,800
100's	250	500	36,000	72,000
110's	275	550	39,600	79,200
120's	300	600	43,200	86,400
130's	325	650	46,500	93,000

Hank Carding suitable for Various Counts, together with Speeds, Draft, and Production.

Cottons.	Counts.	Weight of sliver per 36in. in grs.	Hank carded	Doffer Speed.	Production per 56 hours.	Draft.
	Up to				Lbs.	
Low Cottons	24's	60	·138	15 to 17	850 to 950	90 to 95
American ...	30's	60	·138	13½		
				to	600 to 850	100 to 110
	44's	54	·154	11		
Egyptian ...	40's	54	·154	10½		
	to	to	to	to	360 to 550	105 to 120
	60's	40	·208	9½		
Sea Islands..	70's	40	·208	9		
	to	to	to	to	200 to 325	120 to 150
	150's	30	·277	7		

Duplex Carding Device.—For removing motes, short fibres, leaf, etc., from cotton, before it encounters the wire of the cylinder and flats, thereby assisting the carding operative and securing better results. Consists of a roller covered with special clothing, placed underneath the taker-in, and revolving slowly in the same direction. The roller is provided with a doffing comb for removing the substances eliminated from the cotton.

STRIPPING AND CLEANING FLATS.

In carding on the flat system it is essential that the wire of the flats be kept perfectly clean, otherwise fibres, "neps," etc., accumulate, and what is known as "felting" occurs with the result that the wire clothing is affected, and the quality of the carding suffers. Special devices are made for this purpose, as follows:—

(I.) In which the roller is made up of a combination of bristles and wire clothing. There are two sheets covered with card wire, which partially surround the roller. Between each sheet are wooden lags, filled with bristles of suitable length. Mounted on the roller is a clearer, which prevents any loose cotton from riding on the top of the wire covering. This it does by pressing the cotton into the wire of the brush, which for the time being constitutes a receptacle. When full, the cotton is taken out by the aid of a movable bar with which the apparatus is provided.

(II.) Consists in the combination of a separate wire stripping-brush and a separate bristle brush, both of

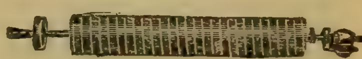
small diameter, which are carried by two discs and revolve round the axis of a central driving shaft. Both brushes are driven by a gear-wheel arrangement, so as to revolve on their own axes, at the same time and in the same direction as they are travelling round the central shaft. A circular comb, also driven by gearing, is attached, which strips both the brushes and thereby keeps them clean and in good working condition.

(III.) In which the comb for stripping the flats is mounted at each end in bearings, capable of sliding towards or away from the flats in suitable guides. They are kept at a given distance from the flats by means of a shoe, which presses against the working seating of flat, the shoe and seating being practically of the same width on face. The comb is kept equidistant from the wire at any desired distance, by adjusting a screw, and the shoe is so shaped that it allows for the "heel" of the flat, and thus ensures the comb being always kept at the proper distance from the wire and prevents the possibility of any damage to the latter.

(IV.) In which the ordinary stripping roller is used and is enclosed in a thin steel casing. Instead of a band-and-pulley arrangement being employed to rotate the brush at the customary high speed, the shaft is provided with an ordinary winch handle. Fourteen revolutions per minute strip the cylinder, the time occupied being 25 seconds; but an alternative method of slow driving by hand can be applied. The apparatus is taken from one card to another as in ordinary stripping.

Cylinder and Doffer Grinder.—Is worked on the traversing wheel principle. To obtain the best results from these grinders they should be fitted with a differential motion, whereby the screw operating the traverse is driven at a slightly reduced speed from the tube. Spring guide-forks are sometimes applied for imparting smoothness in working, and for keeping down the wear and tear of the fork and screw.

Long Grinding Roller.—Is specially designed for use at the mill in grinding the top flats of a carding engine. The roller is a hollow steel shell covered with fillet, and is provided with a traversing movement, which is usually enclosed in casing to keep out dust and "fly"



from the mechanism. A catch is provided for adjusting the roller to the width of the steps.

Gauge for Setting Grinding & Stripping Rollers.—Is designed on the principle of a screw, free to move in a fixed nut, so as to be adaptable to the radius or circles of diameters between 6 and 8 inches. It is formed with gradations or divisional lines representing measurements of one-1,000th of an inch in diameter. When used for

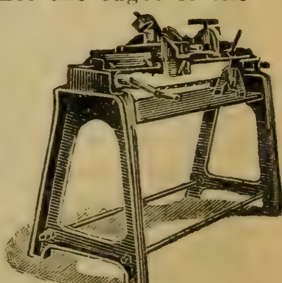
grinding, the diameter of the grinding roller is determined, and the instrument is set to correspond thereto. It is then locked by a small thumb-screw, and the brackets are adjusted at each end until the instrument just touches the card clothing. After each grinding operation the gauge is reset a fraction of an inch to the distance required.

The gauge is mounted on a cross shaft, which rests in the usual grinding-roller brackets. The gauge is moved along the shaft to ascertain the correct position for the brackets in relation to the surface of the wire clothing. The grinding roller is then placed in position, and the grinding proceeds in the usual manner.

FLAT CLIPPING MACHINE.

Function.—To clench the clips of card tops upon the iron flats, and thus enable mill-owners to reclothe the flats on the premises.

Description.—The card-top, with its clips attached to the cloth edges, is placed face down in a vice, and the iron flat is laid upon it with the clips extending on either side. Two cramps are then brought into action to drive the flat tightly home. The vice is then screwed up, and the clips are caused to bed well against the edges of the flat. The clips are bent and secured by a rolling action from two bowls mounted in frames, which are traversed from end to end of the machine by means of chain gear actuated by a hand lever. The machines are made to fix on a bench or with framing to stand on the floor. They are constructed to take in flats up to 45 in. long and 2 in. on the face.



Floor Space.—Bench machine, 5 ft. 1 in. × 1 ft. 7½ in.
Floor ,, 5 ft. 1 in. × 2 ft. 0 in.

FLAT END MILLING MACHINE.

Function.—For use on mill premises in milling and truing-up the ends of card flats that have become worn by constant usage.

Description.—The flats to be milled are secured to their positions alternately in a flat-carrier, the seatings of which determine the "bevel" of the flat end. The amount of "cut" is controlled by a setting-screw, which operates the shaft carrying the cutters. The contour of the flat ends is determined by a "profiled former," which is made according to the particular shape of the flats operated upon. The milling operation is continuous, both the flat sliding faces and the hollow segment being finished simultaneously.

LICKER-IN FILLET MACHINE.

Function.—For winding-on, dressing, and grinding the fillet.

Description.—The winding-on apparatus consists of a sliding head, which receives the fillet from a reel and deposits it into the spiral groove of the licker-in roller. At the same time a revolving "caulking" tool ensures the fillet entering fully into the groove.

The dressing tool also consists of a sliding head, provided with a multiple tool, having wedge-shaped teeth. As the licker-in roller revolves the teeth of the multiple tool follow between the fillet, and in so doing press outward any teeth that have become bent or distorted. The grinding apparatus is of the kind worked on the traverse-wheel principle, the roller being mounted with special emery filleting.

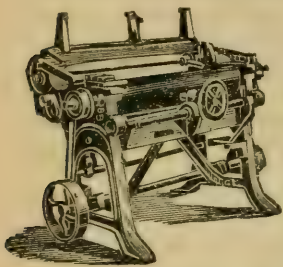
FLAT GRINDING APPARATUS.

Function.—To grind the flats while supported on their working surfaces, and at the proper angle consistent with that of the heel of the flat.

Description.—Consists of a grooved guide (fixed to the grinding bracket), in which slides a toothed bar. To the bottom of this bar is attached a wedge, which is curved to the radius of the flexible bend. The flats are pressed with their working facings against this wedge by means of a weighted lever and slide. As the flats come round, each one seizes a projection on the wedge, and carries the latter along until the wire surface of the flat has passed under the grinding roller. The wedge is then released and resumes its former position by the flat encountering an incline attached to the back of the guide.

GRINDING MACHINE FOR FLATS.

This is a machine designed for dealing with the flats not already mounted on the carding engine.—The flats to be ground are placed over the grinding roller (three flats at a time) in carding position, with the wire pointing downwards and the flat ends resting upon seatings bevelled to correspond with the angle or heel of the flats. The first or lowest flat in the sequence is set to the grinding roller by the wheel of a hand setting-motion; and as the grinding proceeds, each succeeding flat is caused to assume its correct position by means of an automatic feeding arrangement. Mechanism is provided for stopping the machine when the bottom point has been reached. This motion also ensures the flats being ground uniformly, and that they shall test alike after grinding. The flats are traversed by means of cranks operated by suitable gearing.



Pulleys.—9 in. × 3 in. **Speed.**—450 R.P.M.

Floor Space.—5 ft. 10 in. × 2 ft. 10 in.

LOCKING CARDING ENGINE COVERS.

The Home Office (Great Britain) has declared carding engines to be "dangerous" machines under Section 13 (2) of the Factory and Workshops Act, and that a safety locking apparatus must be attached to every machine. An apparatus to meet this requirement and effectively safeguard operatives against accidents must:—

(1) Make it impossible for the cylinder cover to be opened before the cylinder has ceased to revolve.

(2) Make it impossible to move the strap-fork while the cover remains open and unlocked.

Since the issue of the foregoing order, quite a large number of ingenious inventions have been put upon the market. In adopting any one of these devices, it is essential to select only such as can be relied upon not to get out of order, inasmuch as the persons in charge are held responsible for accidents occurring in the event of the motions being out of order at the time. A good motion should be simple in construction and free from parts that are liable to wear or work loose, so that under ordinary conditions the appliance will last as long as

any other working part of a carding engine. The parts should be carefully protected from wilful tampering, and be so arranged that, when closed, the cover is held tightly in its place; also that any attempt to open it while the cylinder is revolving should put no strain whatever upon the working parts.

The motions thus far available for the foregoing purpose are operated from the following movable parts of the carding engine:—

Driving Pulley,	Perforated Rim Pulley,
Cylinder Shaft,	Cylinder Side.

The principles of most of these are described in the issue of "The Cotton Year Book" for 1911. In a recent arrangement the motion consists of two bowls, a notched slide-bar, and a strap lever for keeping the belt on the loose pulley when the door is opened. The two bowls have no fixed centre, but are free to roll against each other inside an iron casing. The small bowl extends slightly beyond the box, while the large one rests inside the notch in the sliding bar. When the cylinder is stopped, and the operator partially turns the small bowl, the action rolls the large bowl free of the notch in the bar, and allows the cover to be opened. If this be attempted while the cylinder is revolving, the movement of the cylinder side, by contact with the large bowl, prevents the bowl from leaving the notch, and the motion cannot act.

REMOVING DUST FROM CARDING ENGINES.

The ill-effects arising from neglect in the removal of dust from carding engines during the stripping and grinding operations are of a two-fold character. Not only is the breathing of it injurious to the work-hands engaged, but much of the dirt and grit of which it is composed settles upon the machines in the immediate vicinity, to the detriment of their working parts, involving excessive wear and tear and causing the production of defective work. There are now obtainable at a comparatively small cost appliances which not only prevent the dust from entering the room, but carry it away as fast as it is made.

A dust-removal scheme should embody the following two essentials: it should remove the dust directly from the point of generation, and should further accomplish this with a minimum amount of air. If the dust can be caught almost as soon as produced, it is quite possible to maintain a clear atmosphere even in a room where a

very dusty process of manufacture is being carried on. By keeping the quantity of air removed, along with the dust, as small as possible, less humidity is taken out of a room where humidified air is required, and this constitutes a saving. The same feature is of value in winter time in the case of factories in which the atmosphere has to be warmed, for the reason that the small volume of air being exhausted with the dust does not increase the cost of heating.

In installations of this character the chief difficulties are the introduction of the necessary hoods or collectors.

These are very troublesome, since they have to be applied as closely as possible to the point where the dust is being produced, and yet must not interfere with the working of the machine or the freedom of the operator.

Installations usually comprise a main tube or duct, placed over the cards and extending the length of the room. This tube is provided with branch tubes, to which are attached hoods, which are placed over each machine. A powerful exhaust fan extracts the dust and discharges it outside the mill.

No. 1 Arrangement.—In which only one branch pipe is used for each row of machines. It is mounted in a carriage suspended by iron rails to the exhaust pipe, and is moved along by the operative from card to card.

No. 2 Arrangement.—In which the hood is detachable, and is carried from card to card and hooked on the respective trunks.

No. 3 Arrangement.—In which a hood is secured to each carding engine directly over the doffing comb; its opening extends along the entire width across the card surface. It is so arranged that in addition to taking away the dust from both cylinder and doffer, it will remove the flat strips. The ordinary stripping roller is used in this case, and the usual conditions are followed.

In another arrangement the fan is dispensed with, and a vacuum pump is employed, which sucks the dust through steel tubing of about 2 inches diameter, and deposits it into a canvas bag. This bag acts also as a filter, by allowing the air to pass into the atmosphere while retaining the dust. The stripping brush used is fitted with a dust-proof cover, to which is attached a short length of flexible tubing. When in use, the end of this tube is coupled to an uptake pipe suspended directly over the machine. The pipe is provided with a valve, which is shut off after each operation. There is an up-

take pipe over each card. A vacuum of about 24 inches is maintained.

Stripper and Dust Remover Combined.

Strips the cylinder and removes the dust therefrom in one operation.

SYSTEM I.—Is an adaptation of the method of cleaning by high-pressure vacuum. The stripping is done by means of nozzles, which traverse the faces of the cylinders and doffers. The air suction is obtained from a high-pressure air pump, which draws into the nozzles the strips, dirt, leaf, seed, etc., from the wire clothing. These are carried away through piping to a suitable receptacle at the end of the mill.

SYSTEM II.—Consists of a metal shell, covered with wire teeth, which takes the place of the ordinary stripping brush. This shell is enclosed in a sheet-metal casing, and is supported in the ordinary grinding roller steps. The shell is provided with air inlets, and as the stripping proceeds the dust made is extracted by means of two small fans, and discharged into a chamber attached to the cover. The chamber is provided with a grid, which allows the air to pass away but retains the dust deposit.

The above systems may be augmented by the employment of an apparatus for separating the dust from the strips. The apparatus (which for convenience may be placed in the Blowing Room) consists of an ordinary scutcher cage arrangement, with fan and dust flue. The fan in this case serves to exhaust the dust and strips from the machines.

Portable Dust Remover.—Is self-contained, carrying its own piping, exhausting fan, and dust chamber. The latter forms a vehicle for the transference of the stripping brush from one carding engine to another; it is so compact and suitably mounted that it may be moved about the shed with but slight exertion. The suction mechanism is operated by an electric motor fixed on the apparatus.

Tubular Stripping Rollers.—Specially adapted for use in connection with portable stripping and dust-removing devices. Is composed of sections of strong tin tubes, soldered together, and strengthened internally by metal discs. To these discs are secured small brass sockets, into which are driven wooden plugs. The plugs are trimmed flush with the roller surface. The roller is fitted with iron ends, and the shafts are of hollow drawn steel, supported inside the roller shell.

USEFUL HINTS.

To card well is to spin well.

Bad carding is generally attributable to over loading the machine or neglecting to strip.

When carding good cotton, the cylinders should be stripped three times and the doffers twice each day. For middling cotton with a heavy production, stripping should take place four times each day.

In clothing a carding engine, care should be taken to have the tension uniform, and the winding-on should proceed steadily, so as not to rupture the wire fillet. Special machines are made for this purpose.

It is absolutely essential that the cylinder and doffers should be covered in such a manner that the fillet will not slip or blister, through change of atmosphere, working strain, or other causes.

The product of a card is governed wholly by conditions, which in turn depend largely on the quality of cotton used.

A heavy lap and long draft is considered to give better production than a card with light laps and short draft. The former does the work proportionately better. A heavy lap and slow feed gives the licker-in or cylinder a longer period to separate the fibre.

Overloading the cylinder is sure to cause more or less "nitty" carding. At the same time it fills the teeth of the flats, and thus prevents them from doing their duty to the fibre.

Keep the flats as clean and in as perfect condition as possible: for they act like a series of combs on the staple, straightening and laying the fibres parallel on the cylinder.

Burnishing of the flats should be undertaken every four or five weeks.

The cylinder and doffer should be lightly ground every two months and the flats every three months; duration of time, about six hours.

By using combination stripping brushes for the revolving flats, burnishing brushes may be dispensed with, and much of the time occupied in flat picking saved to the cardroom operative.

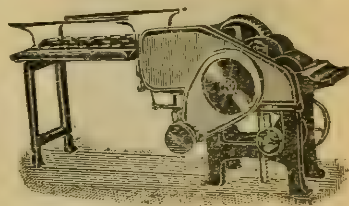
The grinding roller for the flats should have careful attention, to see that the surface touches every point of the wire, and that the correct heel is imparted to the flat wire.

Card clothing should be manufactured from wire which, although soft enough to admit of being bent to the form of the tooth, should be sufficiently hard to maintain a keen edge and withstand the constant wear and tear of the carding process.

There are three kinds of foundation in which the wire teeth are inserted, namely, india, rubber, cotton cloth, and a cloth consisting of wool and cotton, each of which should form a strong fabric of even texture.

COMBING: PREPARING MACHINES AND COMBERS

DERBY DOUBLER.



Function. — Unites into a sheet a given number of carded slivers, and forms them into a lap to be placed behind a second or finisher carding engine. Or the Derby Doubler may be employed in making heavy laps for ribbon lap machines, to be afterwards put behind the combing machine.

Feeding.—From 22 to 72 cans containing the sliver are arranged alongside a V-shaped table, and each sliver therefrom is passed over a spoon-shaped guide, which is connected up to a mechanical stop-motion. The slivers are then formed into laps of the following widths:—

22	cans	make	laps	10 in. to 13 in. wide.
36	,,	,,	,,	17 in to 19 in. ,,
60	,,	,,	,,	23 in., 34 in., & 37 in. wide.
72	,,	,,	,,	41 in. wide.

One, two, and sometimes three, of these laps are placed side by side behind the finisher carding engine, according to the width of the machine.

It is important that these laps be as near as possible of a uniform length and weight; and care should be taken that the machine stop-motion is sensitive and in good working order.

Pulley.—14 in. × 3 in.

Speed.—120 revs. per min.

Power.—½ to ¾ I.H.P., according to width of machine.

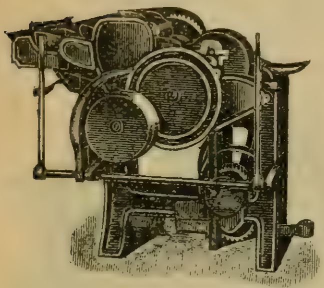
Production.—1,000 to 1,600 lb. per day, according to the number and weight of laps made.

SLIVER LAP MACHINE.

Function. — Unites the slivers from the carding engine, and forms them into laps 7½, 10½, to 12 inches wide, ready for the ribbon lap machine, and to be eventually placed behind the combing machine.

Note.—When ribbon lap machines are not employed, the slivers from the cards are put through one head of drawing before passing through the above-named machine.

and the laps made thereon are taken directly to the comber.



Feeding.—The cans containing the slivers are taken from the card or draw frame, and a number, varying from 14 to 20, are placed behind this machine. The slivers are then passed between three pairs of drawing rollers and two pairs of calender rollers. They are then formed into laps—generally 1 inch narrower than required for the comber, so as to allow for a little spreading-out on the ribbon lap machine.

The machines are provided with mechanical stop-motions for the slivers. A full-lap or measuring motion is also attached, which operates when the required weight or size of lap is completed.

The Draft in this machine should not be more than 2.

Pulleys.—12 in. dia. to 16 in. dia. × 3 in. wide.

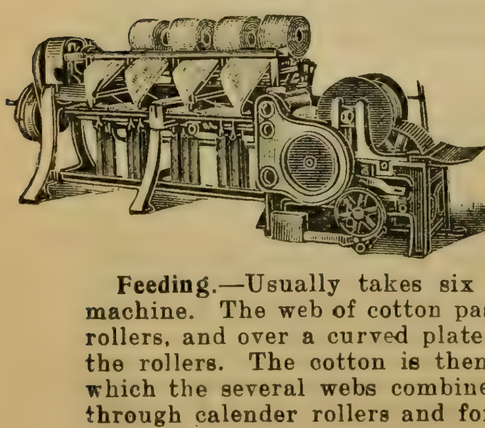
Speed.—200 revs. per min.

Production.—2,600 lb. per 56½ hours, according to weight of lap produced.

Floor Space.—7 ft. 9 in. × 4 ft. 6 in.

Power.—½ I.H.P. per machine.

RIBBON LAP MACHINE.



Function.—Prepares the laps for the comber. The drawing process in the machine straightens the fibres, so that they can be held firmly by the nipper of the comber. This not only assists the comber in its work, but keeps down the quantity of waste.

Feeding.—Usually takes six laps from the sliver-lap machine. The web of cotton passes between four pairs of rollers, and over a curved plate fixed directly in front of the rollers. The cotton is then delivered to a table, on which the several webs combine, and are in turn passed through calender rollers and formed into a lap.

Stop-motions are provided for the length and weight of laps required, and back stop-motions to operate when the webs or laps run off.

The clearers for the rollers may be stationary or on the revolving principle.

The travelling cloth and comb, "Ermen's" principle, can also be applied.

APPROXIMATE WEIGHT OF LAPS

For Heilmann Combers:—

7½ in.	comber laps—about	10 dwt. per yard.
8¾ in.	,, ,, ,,	11½ ,, ,,
10¼ in.	,, ,, ,,	13 to 14 dwt. per yard.

For "Nasmith" Comber:—Usually 10½ in. wide, and ranging from 24 to 30 dwts. per yard.

Pulleys.—14 in. to 16 in. dia.

Speed.—260 revs. per min.

Production.—2,600 to 3,500 lb. per 56½ hours, according to weight per yard of laps made.

Floor Space.—12 ft. × 4 ft. 4 in.

Power.—¾ I.H.P.

DRAW FRAME AND LAP MACHINE COMBINED.

Function.—In place of the foregoing sliver-lap and ribbon-lap machines, this machine may be used for making comber laps directly from the carded sliver.

Feeding.—Consists of three or four deliveries per machine; each delivery may be fed with from 12 to 16 cans of sliver. The slivers are first passed through four pairs of draft rollers, and are afterwards combined to form a lap for the comber.

Pulleys.—16 in. to 20 in. dia.

Speed.—160 to 180 revs. per min.

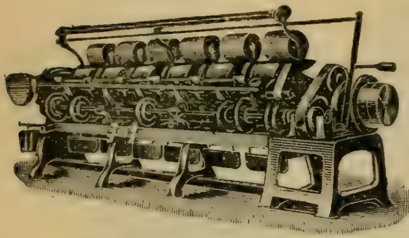
Power.—1 to 1¼ I.H.P.

Floor Space.—

3 delivery machines, 36 cans up	=	12 ft. 2 in. × 5 ft. 3 in.
4 ,, ,, ,,	=	14 ft. 0 in. × 5 ft. 3 in.

Sliver Can Springs.—These are useful devices for reducing the strain put upon the slivers on leaving the cans at the drawing and slubbing frames. Are usually made of tempered steel wire, formed into a series of helical coils a little less in diameter than that of the cans. Securely fastened to the uppermost coil is a flat steel plate, which serves as a table for the cotton to rest upon. As the cotton diminishes in bulk, the spring expands and raises the cotton.

HEILMANN COMBER.



Combing is a process adopted for producing high counts, it being very effective in removing short staples. The same object was formerly attained by a second system of Carding.

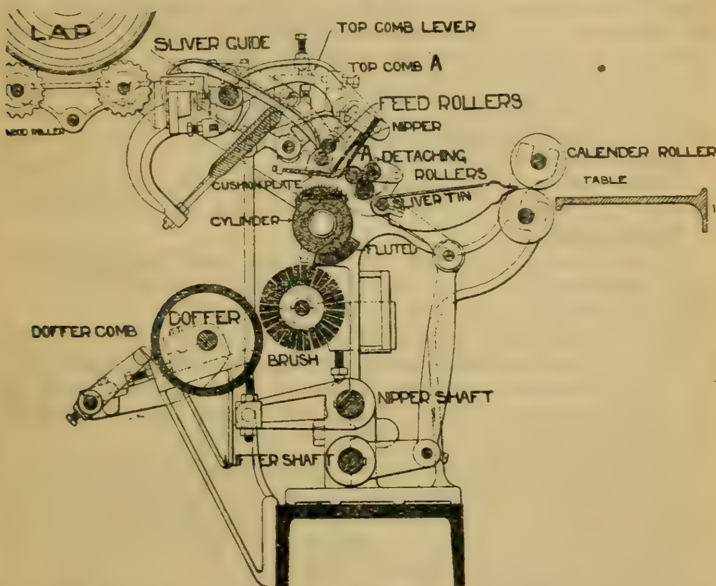
Description of Operations.—The Laps from the Comber or the Ribbon Lap Machine are placed on corrugated wood rollers at the back of the machine. These rollers revolve at a very slow speed, corresponding to the passage of the cotton through the machine. The cotton passes over a highly polished sliver plate on to the feed-rollers, and is fed in an intermittent manner (usually in lengths of about ¼ inch) to a pair of nippers. These consist of upper and lower jaws, arranged to hold the cotton while it is being combed by a cylindrical comb, placed underneath them. This cylindrical comb consists of a fluted part, with a series of needles of various gauges placed in rows, the coarsest entering the cotton first, and finishing with the finest. The above action removes the short fibres, etc., not held by the nippers.

After the needles have passed through the fibres, the fluted part of the cylinder comes under the combed cotton, and at the same time a leather-covered detaching roller is lowered on this fluted part. Its duty is to carry the combed cotton on to two fixed detaching rollers. These rollers have a backward motion, and when the combed fibre is carried forward the two rollers roll backwards and join the previously combed cotton to that coming forward, thus making what is called the "overlap"—joining all the combed slivers together. While this last motion is taking place, the nippers have again opened, to allow more cotton to come forward.

Diagram (p. 81) shews how the cotton is combed and pieced together. There is still, however, the back portion of the sliver to comb. This is done by a comb being placed lower in the path of the cotton, the ends of which are pulled through the comb by the action of the detaching roller.

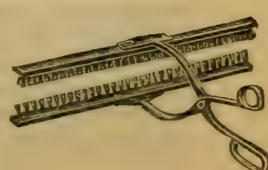
After the piecing has taken place the sliver is deposited into a sliver tin in the form of a web. It is after-

wards drawn through a trumpet-mouthpiece by calender rollers, and is placed on a table, where all the ends from the different heads run side by side to the draw-box at the end of the table. In this journey they pass through three pairs of drawing rollers into a coiling motion, and are placed into cans ready for the drawing frame. All the short, "neppy" fibres and other impurities taken out are left on the cylinder or cylindrical comb.



In order to keep this clean and to prevent them from getting among the good cotton, there is a brush with which the cylinder is cleaned. A doffer covered with wire cleans the brush, which in turn is stripped by a small doffing comb. The waste is then delivered into tins at the back of the machine, or on to a travelling lattice and delivered in tins at the coiler end of the machine. Sometimes a slowly revolving shaft is employed under the doffing comb, which rolls it into laps.

Stripping Brush.—For removing waste cotton from the top combs of combing machines. Is contructed in the form of a pair of scissors, but with the stocks containing the bristles at right angles to the jaws.



Waste Aspirator.—Dispenses with the doffer and stripping comb in removing the waste from the combing cylinder. A strong current of air draws the cotton along a conduit or tube on to a perforated cage. This latter serves as a screen for the removal of impurities, and as it revolves the cotton is deposited (in the form of a fleece) in a can at the end of the frame.

Instead of depositing the waste in the can mentioned, it may be passed through three pairs of draft rollers and condensed into any given weight of sliver, to be delivered into an ordinary can through a coiling arrangement. The sliver thus produced may be used for mixing one or more cans with other cotton at the draw-frame, or it may be used in a special preparation.

Pulleys.—12 in. dia. × 3 in. wide.

Speed.—Single nip, 80 nips, or 305 revs. per min.
Double ditto, 120 nips, or 230 revs. per min.

Production.—

A single-nip machine, 80 nips per minute, with 8½-in. laps working a 9 dwt. lap per yard, produces 40 lb. per head of Sea Island cotton in 56½ hours.

The same machine, working a 10½ dwt. lap, produces 50 lb. per head of Egyptian cotton in 56¼ hours.

A double-nip machine, 120 nips per minute, with 8½-in. laps, working a 9 dwt. lap per yard, produces 58 lb. per head of Sea Island cotton in 56½ hours.

The same machine, working a 10½ dwt. lap, produces 72 lb. per head of Egyptian cotton in 56½ hours.

Floor Space.—For 8½ in. lap machine, with 8 heads, 15 ft. 6 in. by 3 ft. 4 in. in the widest part.

Power.—8-head machine, ⅞ths I.H.P.

Setting Cylinders.—Put in the cylinders and set the index wheel to 5, and with 1⅛ inch gauge between flutes of detaching roller and front edges of segments, make the cylinder fast to the shaft, and then set the detaching roller flutes to 23's gauge from flutes on segments.

Distance between flutes of detaching and feed rollers for Egyptian cotton, $1\frac{13}{16}$ in. Long Sea Islands cotton, $2\frac{1}{16}$ in.

Distance between flutes of detaching roller and front edge of cushion plate for Egyptian cotton, $1\frac{3}{16}$ in. Long Sea Islands cotton, $1\frac{7}{16}$ in.

Setting Nippers. — Put on the cushion plates and set them up to one thickness of writing paper from the nipper knife and to $1\frac{3}{16}$ in. gauge from flutes of detaching roller to front edge of cushion plate (the nipper must be open and the stop screws about ¼ in. through). Next

set the edge of the knife to 19's or 21's gauge from cylinder needles, with the right-hand screws only, and see that the distance between the detaching roller and cushion plate has not altered (a $\frac{3}{8}$'s gauge must be between the point of top screw and nipper stand). Next set the left-hand screws by removing the gauge, and letting point of screw touch the stand; then put on the springs. Move the cam round until the bowl is on the circular part, and put the $\frac{3}{8}$ in. gauge again between the stop screw and stand, then screw up the nuts on one connecting rod until the gauge is just eased. Now turn the cam round until the screw points are eased from the stands, then turn the cam back again as it was and try your gauge between the knife and cylinder needles, and see that all are quite clear and to gauge.

Set Nippers	to 19's	wire gauge	to cylinder needles for	Egyptian Cotton.
„ „	„ 21's	„	„ „	Sea Islands „
„ Top combs	„ 19's	„	„ segment for	Egyptian „
„ „	„ 21's	„	„ „	Sea Islands „
„ „	„ an angle of 28 degrees or to 14's angle gauge.			

Setting Feed Rollers. — For Egyptian cotton with $1\frac{13}{16}$ in. gauge between flutes of feed and detaching rollers make the slides fast, put on the top rollers and springs, and then set the rollers parallel to nipper knife and a convenient distance from it. For Long Sea Islands cotton a $2\frac{1}{16}$ in. gauge must be used between flutes of feed and detaching rollers.

Setting Brushes. — Let the bristles touch brass of the combs of one cylinder, then make a gauge to go between the brush and cylinder shafts, and set others to this gauge.

Brush Tins. — Set them so as to clear the cylinder and doffer about $\frac{1}{8}$ in.

Lap Plates.—Should be set clear of wood and feed rollers when the clearer brush is on.

Lap Guides.—Should be set $\frac{1}{4}$ in. wider than laps and central with boss of feed roller.

Top Detaching Rollers. — Move the 80's wheel on cam shaft out of gear and turn round the cam shaft until the quadrant moves forward, then set the index wheel to 6, and put the 80's wheel in gear. Turn the cam shaft round and see that the roller moves forward at 6. Next clean, oil, and put the brass tubes on the covered top rollers, and put rollers in, weight them, let them rest on the segments, and bring up the lifters until the nearest will admit one thickness of paper

between it and the tubes (the bowl must be on the highest part of the cam). Then move the small slides on the lifters until each will admit one thickness of paper like the first one, and set the cam so that the roller will touch segment at 6½.

Fluted Top Detaching Rollers.—Should be set with the greatest care so that the flutes are parallel with the flutes of bottom roller, and quite clear from the leather roller when same is touching segment.

Top Combs, etc.—For Egyptian cotton set the top combs to 19's gauge from segments of cylinder and to 28 degrees angle or 14's angle of top comb gauge. For Sea Islands cotton set the top combs to 21's gauge. Put on the sliver plate and gear up all the draw-box, coiler, and wood rollers, set the doffer combs, and gear up the doffer shaft.

Notes.—Be sure that all screws, etc., are well screwed up, and that all bearings are well oiled and the cams well greased, and mind the combs do not get damaged. The greater the angle of the combs, the greater the waste; later the nipper closes, ditto; late feeding, ditto, and close setting, ditto. Curling is caused by the detaching roller being badly covered or being short of lubrication, and the top covered roller not touching cylinder segment at the proper time; or top fluted detaching roller not being set perfectly parallel with the flutes of bottom roller.

THE "WHITIN" COMBER.

The principles embodied in this comber are practically the same as in the single-nip Heilmann type. The differences are chiefly in simplification of the working parts, and other structural details. It is a machine capable of running at a very high speed, with a noteworthy absence of vibration. This increased speed not only enhances the output but facilitates the adoption of the machine in mills spinning fine yarns from American cotton.

Pulleys.—12 in. dia., 3 in. wide, 2.66 revs. of driving pulley to one nip. Speed of machine depends upon class of cotton and quality of product. For average work, from 120 to 130 nips per minute.

Cam Shaft.—1 revolution to 2 nips.

Production.—On long-staple cotton, 700 to 1,000 lb. per week of 55 hours.

Floor Space.—17 ft. 6 in. long × 3 ft. 6 in. wide.

Power.—⅝-I.H.P. at 135 nips per minute.

THE "NASMITH" COMBER

Is a modification of the Heilmann machine, having a greater productive capacity and a wider range of adaptability. The mechanism is not so complex; and as the machine commands a greater overlap in the piecings, it can be arranged to comb any length of staple, from $\frac{7}{8}$ in. to 2 in. The machine can be set to take out from 8 to 25 per cent. of waste, according to requirements; but the usual practice to ensure good results is to take out 15 per cent. The machine also differs from the Heilmann Comber in the following details:—

There is no fluted segment on the cylinder.

The opening and closing of the nipper, the raising and lowering of the top comb, and the rotation of the feed-roller, are all worked from the reciprocating motion of the nipper, which latter is driven by a crank.

The leather-covered roller never comes into contact with the cylinder, but rests upon the bottom roller, from which it receives both its rotary and its to-and-fro motion.

The position of the detaching roller is the same as in the Heilmann machine, except that it rotates longer during each stroke.

The setting also is different.

Description of Operation.

The laps from the ribbon lap machine are placed on corrugated wood rollers at the back of the comber. These rollers revolve at a very slow intermittent speed, corresponding to that of the feed rollers. After passing over plates to the feed rollers, the cotton is fed intermittently to a pair of nippers, which hold it while being combed.

The combing cylinder consists of a plain cylindrical part, and 17 rows of needles of different gauges. These latter are arranged so that the coarsest needles enter the cotton first, and are followed up by the finer ones. The object of the cylinder is to remove the short fibres, neps, dust, etc., not held by the nippers. Before all the needles have passed through the cotton, the nipper begins to move forward towards the detaching rollers; and as the last row of needles passes underneath, the detaching rollers turn backwards and deliver the previously combed fleece between the last row of needles and the plain part of the cylinder. This latter takes the fleece underneath the roller.

The nipper by this time has presented the newly combed fleece to the nip of the rollers. The rollers now

begin to turn forward and seize the tips of the fibres, pulling the remaining part through the top comb, which at the time drops down into the path of the cotton as the nippers are raised. The nippers continue to advance, and the roller to move away; but the latter is eventually overtaken by the nippers when they arrive at the destination of their respective paths. The rollers continue their rotary movement a little longer to make the separation complete, which is finally effected by the backward movement of the nipper. The nipper leaves a short portion of the combed fleece projecting from the rollers. By this means, and the foregoing mechanical movements, an overlap of from $1\frac{3}{4}$ to 2 inches is obtained.

Weight of Laps.—$10\frac{1}{2}$ in. wide for various cottons.

For Superfine Sea Islands	12-18 dwts. per yard.
For Florida Cottons	18-22 „ „
For Egyptian „	24-27 „ „
For American „	26-32 „ „

Speeds.—

335	revs.	per min.,	or 86	nips,	for	Finest Sea Island Cotton
350	„	„	„ 90	„	„	Florida Cotton.
370	„	„	„ 95	„	„	Egyptian and best American Cotton.
390	„	„	„ 100	„	„	Coarse work.

Pulleys.—10 in. dia.

Production.—Depends upon the cotton. If working at 100 beats per min., with 25 dwt. laps, and allowing 15 per cent. for waste, a six-head machine produces 800 lb. in 50 hours. Generally, if the weight (in grains) of a yard of lap (after deducting the waste) be divided by 18.7, it will give in lb. the weight produced per head per hour.

Floor Space.—

4 heads, $10\frac{1}{2}$in. lap	10ft. 11in. × 3ft. 5in.
5 heads, $10\frac{1}{2}$in. lap	12ft. 7in. × 3ft. 5in.
6 heads, $10\frac{1}{2}$in. lap	14ft. 3in. × 3ft. 5in.

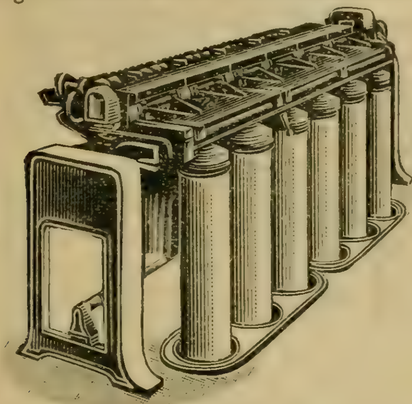
Power.—6-head machine, 0.76 I.H.P.

Owing to the small diameter and excessive length of the detaching rollers used in the Heilmann type of comber, it is difficult to draw on the leather "cots" sufficiently tightly. The average leather coverer, in attempting to do this, frequently bursts the tube, thus entailing undue waste. There are, however, experts who have special machinery for this work, and whose services can be utilised—to the mill manager's advantage.

DRAWING:

THE DRAWING FRAME.

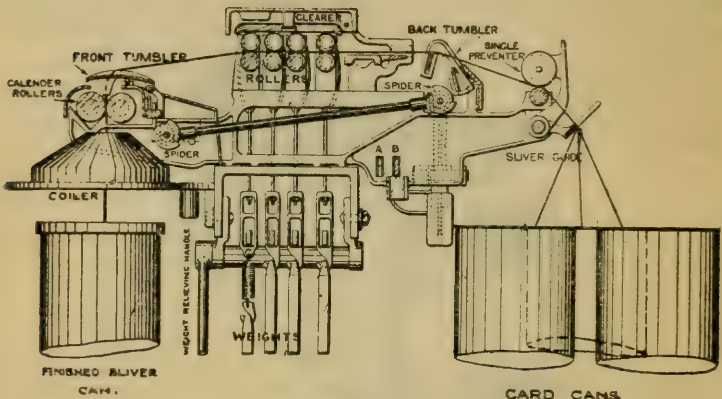
Function and Application. — Draws several slivers taken from the card, and attenuates them to the dimensions of one. The slivers thus become blended together, and any irregularities therein are eliminated. The slivers



are put through the drawing heads twice, thrice, or four times, according to the class of cotton being treated. For low qualities in spinning up to 12's counts, two passages of six ends up are sufficient; and for ordinary American cotton, three passages of six ends up. For Egyptian, Sea Island, and other long-staple cottons, either of two courses is followed, namely:—Four times through with six ends up, or three times through with eight ends up. By the latter plan, one head of drawing can be dispensed with.

Description and Feeding.—Cans filled with the sliver from the Card or Comber (as the case may be) are placed at the back of the machine—six or eight cans to each delivery. The slivers are passed up through guides, and sometimes through a pair of "single" prevention or tension rollers, over a well-balanced spoon, to the back roller. The slivers at this point pass side by side through the four pairs of rollers. Each pair has a varying draft, the total reaching to six or eight, according to the number of ends at the back. The slivers on leaving the feed rollers pass to a trumpet condenser—becoming a single sliver—through a pair of calender rollers to the coiler, from which it is finally coiled into a can ready for the Slubbing Frame.

There is a front and back stop motion to this machine, so that if the sliver comes through too thin, or when it is too thick, the machine stops. This



motion is either mechanical or electric, as may be desired.

There are many devices for cleaning the top rollers, namely:—

(1) The stationary flat wooden clearers, suspended in the centre and covered with flannel clearer-cloth, which rests on the rollers.

(2) The "Ermen" clearer, consisting of an endless flannel clearer, cloth-driven at a positive speed, and cleaned automatically by means of a comb.

(3) Revolving wooden clearers.

(4) Revolving clearer cloth; the cloth is carried by two rollers, and receives its motion by friction from the top rollers.

Traverse motions are supplied, whereby the slivers are traversed to prevent undue wear of the leather covering the rollers. Stop-motions are sometimes supplied with these machines to prevent the cans from overflowing.

Draft.—The draft for six ends up is generally 6 in the first head, increasing to 6.25 in the third head. For eight ends up, the draft is 8 at the first head, increasing to 8.5 at the third head.

Diameter and Speeds of Rollers
For Different Counts.

Cotton.	Dia. Front roller.	Revs. per min	Counts.	Hank Roving.	Production per 56 hours.
Indian & Low American...	$1\frac{1}{8}$-$1\frac{1}{4}$ in	400	up to 20's	·125 to ·140	900 to 1,030 lb.
American......	$1\frac{3}{8}$ in.	360	„ 30's	·150	950 „
„	„	300	„ 45's	·170	750 „
Egyptian	$1\frac{1}{2}$ in.	280	50's–60's	·208	600 „
„	„	250	60's–80's	·208	510 „
„	„	210	80's–100's	·231	375 „
„ and Sea Island..	„	210	120's	·277	325 „

The front line of rollers should be case-hardened all over; the second, third, and fourth need only be case-hardened at the necks and squares. Damage to the flutes is thus prevented and there is less wear on the necks.

When double-boss top rollers are used, the front row should have loose bosses, to prevent cutting of the leather coverings. With single-boss rollers there are only two selvedges, instead of four, as in double bosses. When loose bosses are supplied to each end of single-boss rollers, they are an advantage almost equal to loose bosses throughout.

Dead-weighting of the rollers necessitates the use of a relieving motion, which must be put into operation during long stoppages, to prevent the formation of flat places on the rollers.

Great attention should be given to the rollers, to see that they are kept true and even. They should always be carefully tested by gauge before putting in the frame, especially when there is more than one boss to an arbor;—otherwise they will not draw even, and the sliver may be damaged and show a cut or uneven place.

Weak yarn is caused by over-drawing; the fibres become strained, until their natural convolutions are destroyed and the staple becomes brittle.

For short-staple cotton, or when the slivers are very light, the latter should be assisted from the cans. A device is provided for this purpose, which also acts as a preventer of "singles." Without this device, the slivers are liable to become stretched.

Metallic instead of leather-covered top rollers may be used for certain classes of work; these effect a great saving in leather, and increase production.

Pulleys.—16 in. dia. × 3 in. wide.

Speeds.—250 revs. per min.

Production. — 700 to 1,000 lb. per finishing deilivery in 56½ hours, according to quality of cotton.

Floor Space.—

Width, delivery coilers, one side only, six ends up, 4 ft. 4 in.

Width, coilers on either side, six ends up, 5 ft.

Length, according to number of deliveries.

Rule to Ascertain Length.—Number of dels. × gauge. Add 20½ in. for each head + 16 in. for driving end.

Power.—12 deliveries per 1 I.H.P.

USEFUL FORMULÆ.

Draft in draw frame × Hank carding ÷ Number of ends put up at draw box = Hank drawing.

Number of ends put up × Hank drawing required ÷ Hank carding = Draft required.

Number of ends put up × Hank drawing ÷ Draft in draw frame = Hank carding required.

Number of ends put up × Weight of carding ÷ Draft in frame = Weight of drawing.

Number of ends put up × Weight of carding ÷ Intended weight of drawing = Draft required.

Weight of drawing × Draft ÷ Number of ends put up = Weight of carding.

Required number of grains × Change wheel ÷ Number of grains on frame = Change pinion required when altering from one weight to another.

Hank being made × Pinion on frame ÷ Hank wanted = Change pinion required when altering from one part of a hank to another.

Crown wheel × Back roller wheel × Diameter of front roller ÷ Front roller wheel × Change pinion × Diameter of back roller = Draft in draw frame.

Front roller wheel × Driver of second roller × Diameter of second roller ÷ Wheel driven from front roller × Wheel on second roller × Diameter of front roller = Draft between first and second rollers.

Wheel on second roller × Wheel driving third roller ÷ Wheel driving second roller × Wheel on third roller = Draft between second and third rollers.

Wheel on third roller × Wheel driving fourth roller ÷ Wheel driving third roller × Wheel on fourth roller = Draft between third and fourth rollers.

Draft required × Change pinion × Diameter of back roller ÷ Crown wheel × Back roller wheel × Diameter of front roller = Front roller wheel necessary to give a required draft.

Front roller wheel × Pinion wheel × Draft × Diameter of back roller ÷ Back roller wheel × Diameter of front roller = Crown wheel for a required draft.

Front roller wheel × Draft ÷ Crown wheel × Back roller wheel = Change pinion for a required draft.

Front roller wheel × Change pinion × Draft ÷ Crown wheel = Back roller wheel for a required draft.

To find a Full Set of Wheels:—Take any two wheels for the front roller and crown wheel, then divide the crown wheel by the front roller wheel; and as the quotient stands to the draft, so does the pinion stand to the back roller wheel.

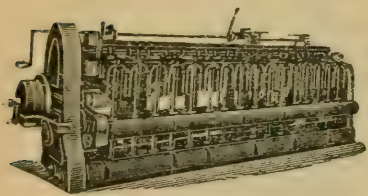
FLYER OR SPEED FRAMES.

The sliver at this stage, after the fibres have previously been carded, straightened, laid parallel to one another, and made even through its whole length, is still too thick, and requires further drawing before it can be regarded as sufficiently fine to complete the operation of making it into yarn. In order to effect this additional attenuation, and to get it to the required weight per yard, Flyer and Speed Frames are employed. These also multiply the number of doublings to preserve the evenness already attained in the previous machines, and at the same time to put in twist or turns.

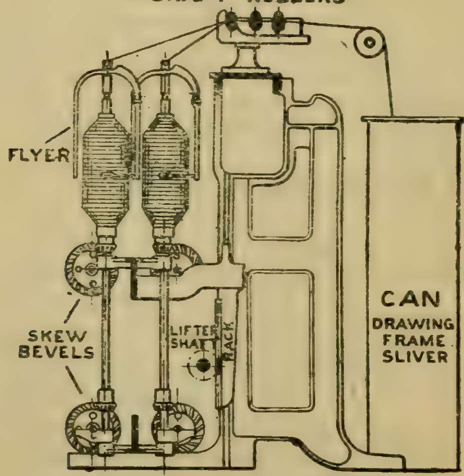
These machines have for their object:—(1) Reduction of the thickness or weight of sliver; (2) Making even of the sliver; (3) Adding twist to the sliver or roving; (4) Winding of the roving upon bobbins.

The frames consist of—(1) the Slubbing Frame, which receives the cotton in cans from the drawing frame; followed by (2) the Intermediate Frame, and (3) the Roving Frame. In the case of fine counts (say Egyptian and Sea Islands cotton) a Fine Roving or " Jack " Frame is introduced.

Slubbing Frame.



Function. — Receives the attenuated sliver from the Draw Frame, puts in a slight draft, and imparts to the cotton its first twist. The cotton is put up behind this machine in cans containing the coiled sliver. It is passed through three rows of draft rollers, twisted by means of flyers, and finally wound upon wooden bobbins or tubes. It is only necessary at this stage to put enough twist



SECTION OF SLUBBING FRAME.

in the cotton to ensure good running, and to make the rove sufficiently strong to unwind in the creel of the intermediate frame without breaking. The lift or traverse for the bobbins on these frames is usually 10 in. or 11 in.; but sometimes 12 in. are made.

Pulleys.—14 in. to 18 in. diameter.

Speeds.—American cotton, spindles, 550 to 650 revs. per min.

Egyptian and Sea Island, spindles, 400 to 500 revs. per min.

Draft.—American cotton, 4 to 5.
Egyptian cotton, 5 to 5.4.

Production.—In hanks per 56½ hours for the following classes of cotton:—

Low American	Producing	0.50 hank	=60	hanks.
Mid. and Good American ...	„	0.75 „	=56	„
Egyptian and Sea Island ...	„	0.75 „	=55	„
„ „ ...	„	1.00 „	=52	„

Floor Space.—Width, including cans, 4 ft. Length, according to number of spindles.

Rule to Ascertain Length.—Gauge of spindles × half the number of spindles in frame. Add space taken up by gearing and off end (usually 3 ft. for single gearing and 5 ft. for double gearing).

Power.—46 to 52 spindles per I.H.P.

Intermediate Frame.

The bobbins made on the Slubbing Frame are placed in a creel on this machine. The rovings of two of these bobbins are run and twisted together, passing through three pairs of rollers (as in the previous machine), and are made into bobbins having a lift or traverse of 10 or 11 inches. There is slightly more draft and twist put into the roving on this machine than in the Slubbing Frame.

Pulleys.—14 in. to 16 in. dia.

Speeds.—American cotton, spindles, 770 to 850 revs. per min.

Egyptian cotton, spindles, 680 to 750 revs. per min.

Draft.—American cotton, 4.5 to 5.5.
Egyptian cotton, 5.0 to 5.75.

Production.—In hanks per 56½ hours for the following classes of cotton:—

Low American	Producing	1.5 hank	=51	hanks.
Mid. American	„	1.5 „	=50	„
American	„	1.75 „	=46	„
Egyptian and Sea Island ...	„	2.5 „	=47	„
„ „ ...	„	3.0 „	=45½	„
„ „ ...	„	4.25 „	=39	„

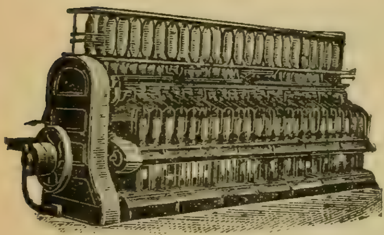
Floor Space. — Width, 3 ft. Length, according to number of spindles.

Rule to Ascertain Length.—Gauge of spindles × half the number of spindles in frame. Add space taken up by gearing and off end (usually 3 ft. single gearing and 5 ft. for double gearing).

Power.—60 spindles per I.H.P. This varies according to gauge of frame.

Roving Frame.

Function.—Receives the twisted roving from the Intermediate Frame, and adds more twist and draft. In other respects the principle is the same as that of the Intermediate Frame, with two bobbins per spindle to ensure strength and uniformity, as in the Intermediate Frame.



The lift or traverse in these frames varies according to the class of cotton and hank roving that is being produced. The usual length is 6 or 7 inches, while for very coarse work sometimes 8 inches is used.

Pulleys.—16 in. dia.

Draft.—American cotton, 5 to 6.
Egyptian cotton, 5 to $6\frac{1}{2}$.

Speeds.—Spindles make 900 to 1,100 revs. per min., according to quality of cotton.

Production.—In hanks per $56\frac{1}{2}$ hours for the following classes of cotton :—

American	Producing	4	bank	=42	hanks.
"	"	5	"	=39	"
"	"	6	"	=36	"
Egyptian and Sea Island	"	6	"	=36	"
" "	"	7	"	=34	"

Floor Space. — Width, 3 ft. Length, according to number of spindles.

Rule to Ascertain Length.—Gauge of spindles × half the number of spindles in frame. Add space taken up by gearing and off end (usually 3 ft. for single gearing, and 5 ft. for double gearing).

Power.—70 to 80 spindles per I.H.P., according to gauge of frame.

Fine Roving or "Jack" Frame.

Function.—Receives the twisted rove from previous machine when spinning Egyptian or Sea Island cotton. Adds more twist and draft. In other respects the same as the roving frame, and with two bobbins per spindle. The lift or traverse of these machines is usually 5 or 6 inches. **Pulleys.**—12 in. to 16 in. dia.

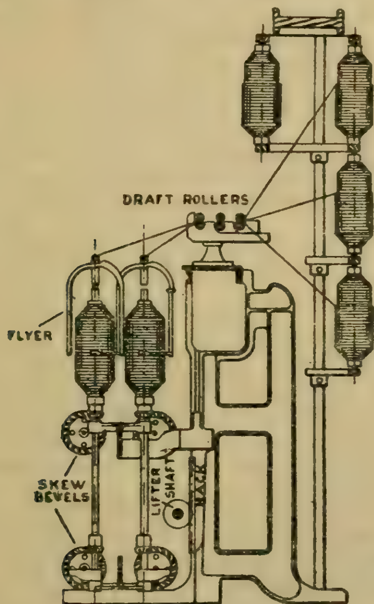
Speeds.—Spindles make 1,000 to 1,200 revs. per min., according to quality of cotton.

Draft.—Should never exceed 6¼ to 7.

Production.—In hanks per 56½ hours for the following classes of cotton:—

Egyptian	Producing	16 hank	=33	banks.
Sea Island	„	18 „	=32	„
„	„	30 „	=20.4	„

Floor Space.—Width, 3 ft. Length, according to number of spindles.



SECTION OF ROVING FRAME.

RULE to Ascertain Length.—Gauge of spindles × half the number of spindles in frame. Add space taken up by gearing and off end (usually 3 ft. for single gearing and 5 ft. for double gearing).

Power.—90 to 100 spindles per I.H.P., according to gauge of frame.

Do not over-speed flyer frames, as excessive speeds cause defects in the rove and undue wear and tear of the machine. Excessive speed also causes more frequent breakages, and consequent loss in production.

Dia. of Top and Bottom Rollers for the Different Speed Frames suitable for the Different Cottons.

Cotton	Machines	Bottom Rollers			Top Rollers		
		1st	2no	3rd	1st	2nd	3rd
Indian	Slubber	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{15}{16}$	$\frac{15}{16}$	$\frac{15}{16}$
	Intermediate ...	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$
	Roving	$1\frac{1}{16}$	$\frac{13}{16}$	1	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
American	Slubber	$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{4}$	1	1	1
	Intermediate ...	$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{4}$	1	1	1
	Roving	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{13}{16}$
Egyptian and Sea Island ...	Slubber	$1\frac{3}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{1}{16}$
				or	$1\frac{1}{2}$	$1\frac{1}{16}$	$2\frac{1}{2}$
	Intermediate ...	$1\frac{3}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{16}$	$1\frac{1}{16}$	$1\frac{1}{16}$
				or	$1\frac{1}{2}$	$1\frac{1}{16}$	$2\frac{1}{2}$
	Roving	$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	1	$1\frac{1}{8}$
				or	$1\frac{1}{8}$	1	$2\frac{1}{2}$
Egyptian	Fine Jack	$1\frac{1}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{16}$	2 or $2\frac{1}{4}$
Sea Island.........		$1\frac{1}{4}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{16}$	$2\frac{1}{4}$

The setting of rollers is regulated by the length of staple being spun, etc. The thickness of the sliver being drawn and the amount of draft being put in all affect the setting, and therefore it is impossible to give a fixed distance. Thick roving and extra twist require open setting; fine and slackly twisted roving, close setting.

Weighting.—For Indian and American cotton separate weights to front line of rollers, and the middle and back saddles weighted, for all frames.

For Egyptian and Sea Island cotton dead-weighting to front line of roving, and fine jack with middle and back self-weighted. Sometimes this system is adopted on the intermediate frames.

Do not overweight the draft rollers. To do so not only shortens the life of the leathers, but increases the demand for power, and weaker yarn is produced.

Sliver Cans.—Are now made of steel or compressed fibre, the latter being considerably lighter than the former. By introducing a false bottom in addition to the regular rigid one, and inserting between the two a series of spiral springs, these cans are made to withstand banging on the floor or other rough usage.

Approximate Hank Roving for Different Counts.

Counts	Cotton	Slubbing Frame	Intermediate Frame	Roving Frame Hank Roving	
		Hank Roving	Hank Roving	Mule Yarn	Ring Yarn
10-12	Indian	$\frac{5}{8}$		$1\frac{3}{4}$	
16-24	American	·5	$1\frac{1}{8}$ to $1\frac{1}{4}$	$2\frac{1}{2}$ to $3\frac{1}{4}$	3 to $3\frac{1}{2}$
26-30	„	·625	$1\frac{3}{8}$ to $1\frac{1}{2}$	$3\frac{1}{4}$ to $4\frac{1}{4}$	$3\frac{3}{4}$ to $4\frac{1}{4}$
32-38	„	·75	1·6	$4\frac{1}{4}$ to $4\frac{3}{4}$	$4\frac{1}{2}$ to 5
40-44	„	·8	1·75	5 to $5\frac{1}{4}$	$5\frac{1}{2}$ to 6
50-60	,	·875	1·82	$5\frac{1}{4}$ to $5\frac{1}{2}$	7 to $7\frac{3}{4}$
40 50	Egyptian	$\frac{7}{8}$ to 1	$2\frac{3}{4}$ to 3	9 to $9\frac{1}{2}$	
60	„	$1\frac{1}{8}$	$3\frac{1}{2}$	11 to $11\frac{1}{4}$	
70	„	$1\frac{1}{4}$	$3\frac{3}{4}$	12 to 13	
80	„	$1\frac{5}{16}$ to $1\frac{3}{8}$	4	14	
90	„	$1\frac{3}{8}$ to $1\frac{7}{16}$	$4\frac{1}{4}$	15 to 16	
100	„	$1\frac{1}{2}$	$4\frac{1}{2}$	16 to 17	

Approximate Weight of Cotton on Various Sizes of Bobbins.

Slubbing Bobbin	12in. × 6in. = 44oz.	Roving Bobbin	8in. × 4in. = 14oz.
„ „	11in. × $5\frac{1}{2}$in. = 32oz.	„ „	7in. × $3\frac{1}{2}$in. = 10oz.
Intermediate „	10in. × 5in. = 24oz.	„ „	6in. × 3in. = 7oz.
„ „	9in. × $4\frac{1}{2}$in. = 18oz.	„ „	[illegible]in. × $2\frac{1}{2}$in. = 5oz.

Weight of Cotton on bobbin in lb. × Hank roving × 840 × 0.6 = Length in inches on bobbin.

Length on bobbin × Twist per inch = Total twist in roving on the bobbin.

Total twist on bobbin ÷ Revolutions of spindle per minute = Minutes occupied in building the bobbin.

The above weights may be increased by the application to the frames of a recently-invented shortening or tapering motion, which works in conjunction with the tapering rack. For example, an intermediate frame producing one hank roving for 60's Egyptian cotton has been found to take 1 hour 55 minutes longer to run off in the roving creel than the time usually occupied in the case of an ordinarily built bobbin. Thus there are fewer doffings, and creeling is not so frequently necessary.

Oiling, Cleaning, etc.—

Attention should be given to the oiling of the different parts of the frame, and no fluff or "fly" should be allowed to accumulate thereon.

Top Rollers.—Oil every two days.

Saddles and Bottom Rollers.—Every three days.

Spindles. with ordinary footsteps.—Weekly.

Spindles, with oil-retaining footsteps.—Monthly.

Long Collars.—Clean inside every nine months.

Differential Motion.—Oil every two days and clean thoroughly every six to seven weeks.

———

Fluff or "fly" should be wiped off at every doffing, and the slits in the spindles should be cleaned once a month.

Loose boss rollers may be efficiently lubricated by causing the arbour or spindle to remain stationary and the leather-covered bosses to rotate thereon. There is a spirally-cut channel in the spindle, and an outlet at either end for the admission of the oil.

Examine leathers on rollers, and either re-cover or true up worn ones. Sliver traverse motions effect a great saving in leather, and when used should be of the variable kind, having as little "dwell" as possible at the end of each stroke.

Care should be taken that there is no vibration in the back and middle draft rollers, breakages and weaker places in the yarn being caused thereby. This often arises from want of oil in the bearings, or is due to the frame not being level.

Self-Lubricating Long Collar.—Made of thin drawn steel tubing, and is very light and very strong. Inside the collar at the top is inserted a cast-iron bush, 2½ inches long. The ring, which rests upon the frame rail, is forced upon the shell, and is secured in its place by an indent in that part of the shell. The spindle is lubricated through a hole at the side of the collar, which communicates with a felt ring, against which the spindle works. The oil being retained for a lengthy period, the supply of lubricant lasts fully a week. As the oil trickles from the felt, its course is diverted by a small conical bush, which causes it to flow out again through another hole in the collar at the point where the bobbin-wheel works, thus lubricating the latter with the same supply of oil.

Chain Swing Motion.—To overcome the irregular movement transmitted to the bobbins and the alternate variation in the stretch of the rove, which result from the use of the ordinary swing and spur wheels.

Consists in employing two carrier wheels, round which a link chain passes on its way from the bobbin-driving wheel to the bobbin-shaft wheel. A crank framing con-

nects the two, and by adjusting itself automatically at all the stages of the lift it keeps the chain at a uniform tension and prevents variation.

Hollow-frame Spindles.—Are made from weldless steel tubing forged down at one end to receive the flyer, and at the other end to take in a hardened steel stud to form the spindle foot. Although considerably lighter than those made solid, these spindles are quite as strong, and are especially suited to the high speeds at which flyer frames are now run.

Guard for Speed Frames.—For enabling spinners (British) to conform to the requirements of H.M. Factory Inspectors, in fencing the skew-gear wheels. The guard, which is of sheet-steel, is curved to extend from the back to the front plate underneath the bobbin wheels. It is provided at the edges with slots, which form key-holes to fit over studs on the front and back plates. Slots are also provided at the underside to allow of the passage of the guard beyond the spindles.

USEFUL FORMULÆ.

Revolutions per spindle per minute ÷ Inches delivered per minute = Turns per inch.

Square root of present counts × Wheel on frame ÷ Square root of required counts = Twist wheel and lifter wheel.

Present counts × Wheel on frame ÷ Required counts = Draft wheel.

Square root of required counts × Wheel on frame ÷ Square root of present count = Ratchet wheel.

8⅓ × Length wrapped in yards ÷ Weight of rove in grains = Counts or hank roving.

8⅓ ÷ Hank roving = Weight per yard of rove in grains.

Front roller wheel × Pinion wheel × Diameter of back roller ÷ Crown wheel × Back roller wheel × Diameter of front roller = Draft.

Speed of line shaft × Diameter of pulley thereon × Wheel on frame shaft × Wheel on spindle shaft ÷ Diameter of frame pulley × Spindle shaft wheel × Driving wheel on spindle = Speed of spindles.

Speed of line shaft × Diameter of driving drum × Twist wheel on frame shaft × Wheel on bottom cone drum

end ÷ Front roller wheel × Wheel on bottom cone drum × Pulley on frame end = Speed of front roller.

Wheel on spindle end × Wheel on spindle shaft end × Twist wheel on same shaft × Wheel on top cone drum shaft ÷ Wheel working into spindle shaft wheel × Wheel on main shaft × Wheel on top cone drum (opposite end) × Front roller wheel = Number of turns of spindle for one of front roller.

Number of turns of spindle for one of front roller ÷ Circumference of front roller = Turns per inch.

Multipliers of Square Root for Turns per Inch.

Cottons	Slubbing	Intermediate	Roving	Fine Roving
Sea Island ...	0·7	0·78	1·1	0·9
Egyptian	0·9	0·95	1·15	0·95
American	1·1	1·1	1·25	
Indian	1·3	1·2	1·25	

WRAP TABLES.

I.

WRAP TABLE FOR 15 YARDS.

From .5 to 1 Hank.

Hank	Dwts.	Grains	Hank	Dwts.	Grains	Hank	Dwts.	Grains
·5	10	10·	·67	7	18·56	·84	6	4·8
·51	10	5·09	·68	7	15·82	·85	6	3·05
·52	10	0·38	·69	7	13·15	·86	6	1·34
·53	9	19·84	·7	7	10·57	·87	5	23·67
·54	9	15·48	·71	7	8·05	·88	5	22·04
·55	9	11·27	·72	7	5·61	·89	5	20·44
·56	9	7·21	·73	7	3·23	·9	5	18·88
·57	9	3·29	·74	7	0·91	·91	5	17·36
·58	8	23·51	·75	6	22·66	·92	5	15·86
·59	8	19·86	·76	6	20·47	·93	5	14·4
·6	8	16·33	·77	6	18·33	·94	5	12·97
·61	8	12·91	·78	6	16·25	·95	5	11·57
·62	8	9·61	·79	6	14·22	·96	5	10·2
·63	8	6·41	·8	6	12·25	·97	5	8·86
·64	8	3·31	·81	6	10·32	·98	5	7·55
·65	8	0·3	·82	6	8·43	·99	5	6·26
·66	7	21·39	·83	6	6·6	1·	5	5·

II.

WRAP TABLE FOR 15 AND 30 YARDS.

From 1 to 5's.

Hank	15 Yards		30 Yards		Hank	15 Yards		30 Yards	
	Dwts.	Grains	Dwts	Grains		Dwts.	Grains	Dwts.	Grains
1·	5	5·	10	10·	3·1	1	16·32	3	8·64
1·1	4	17·63	9	11·20	3·2	1	15·06	3	6·12
1·2	4	8·16	8	16·33	3·25	1	14·46	3	4·92
1·25	4	4·	8	8·	3·3	1	13·87	3	3·75
1·3	4	0·15	8	0·3	3·4	1	12·76	3	1·52
1·4	3	17·28	7	10·57	3·5	1	11·71	2	23·42
1·5	3	11·33	6	22·66	3·6	1	10·72	2	21·44
1·6	3	6·12	6	12·25	3·7	1	9·78	2	19·56
1·7	3	1·52	6	3·05	3·75	1	9·33	2	18·66
1·75	2	23·42	5	22·85	3·8	1	8·89	2	17·78
1·8	2	21·44	5	18·88	3·9	1	8·05	2	16·1
1·9	2	17·78	5	11·57	4·	1	7·25	2	14·5
2·	2	14·5	5	5·	4·1	1	6·48	2	12·97
2·1	2	11·52	4	23·04	4·2	1	5·76	2	11·52
2·2	2	8·81	4	17·63	4·25	1	5·41	2	10·82
2·25	2	7·55	4	15·11	4·3	1	5·06	2	10·13
2·3	2	6·34	4	12·69	4·4	1	4·4	2	8·81
2·4	2	4·08	4	8·16	4·5	1	3·77	2	7·55
2·5	2	2·	4	4·	4·6	1	3·17	2	6·34
2·6	2	0·07	4	0·15	4·7	1	2·59	2	5·19
2·7	1	22·29	3	20·59	4·75	1	2·31	2	4·63
2·75	1	21·45	3	18·9	4·8	1	2·04	2	4·08
2·8	1	20·64	3	17·28	4·9	1	1·51	2	3·02
2 9	1	19·1	3	14·2	5·	1	1·	2	2·
3·	1	17·66	3	11·33					

III.

WRAP TABLE FOR ROVING 30 AND 60 YARDS,

And from 5 to 15 Hanks.

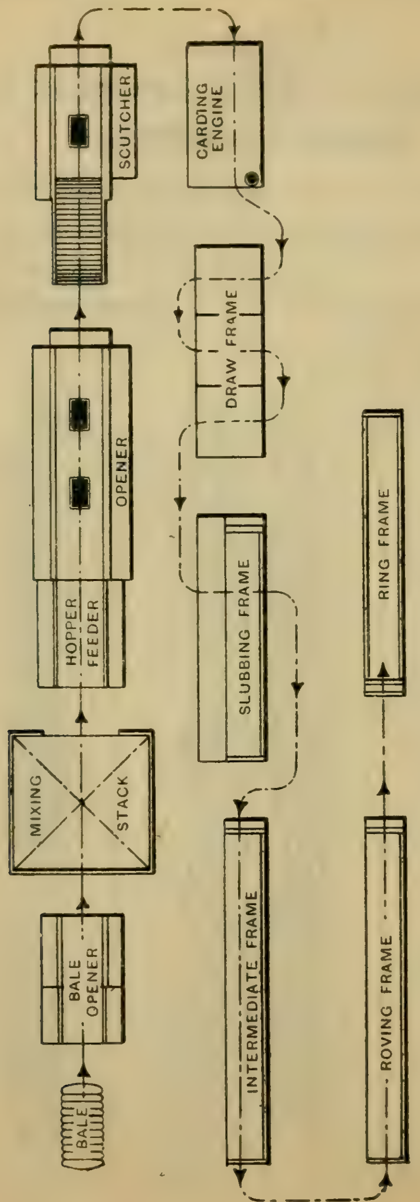
Hank	30 Yards		60 Yards		Hank	30 Yards		60 Yards	
	Dwts.	Grains	Dwts.	Grains		Dwts.	Grains	Dwts.	Grains
5·	2	2·	4	4·	7·6	1	8·89	2	17·78
5·1	2	1·01	4	2·03	7·7	1	8·46	2	16·93
5·2	2	0·07	4	0·15	7·75	1	8·25	2	16·51
5·25	1	23·61	3	23·23	7·8	1	8·05	2	16·1
5·3	1	23·16	3	22·33	7·9	1	7·64	2	15·29
5·4	1	22·29	3	20·59	8·	1	7·25	2	14·5
5·5	1	21·45	3	18·9	8·1	1	6·86	2	13·72
5·6	1	20·64	3	17·28	8·2	1	6·48	2	12·97
5·7	1	19·85	3	15·71	8·25	1	6·3	2	12·6
5·75	1	19·47	3	14·95	8·3	1	6·12	2	12·24
5·8	1	19·10	3	14·2	8·4	1	5·76	2	11·52
5·9	1	18·37	3	12·74	8·5	1	5·41	2	10·82
6·	1	17·66	3	11·33	8·6	1	5·06	2	10·13
6·1	1	16·98	3	9·96	8·7	1	4·73	2	9·47
6·2	1	16·32	3	8·64	8·75	1	4·57	2	9·14
6·25	1	16·	3	8·	8·8	1	4·4	2	8·81
6·3	1	15·68	3	7·36	8·9	1	4·08	2	8·17
6·4	1	15·06	3	6·12	9·	1	3·77	2	7·55
6·5	1	14·46	3	4·92	9·1	1	3·47	2	6·94
6·6	1	13·87	3	3·75	9·2	1	3·17	2	6·34
6·7	1	13·31	3	2·62	9·25	1	3·02	2	6·05
6·75	1	13·03	3	2·07	9·3	1	2·88	2	5·76
6·8	1	12·76	3	1·52	9·4	1	2·59	2	5·19
6·9	1	12·23	3	0·46	9·5	1	2·31	2	4·63
7·	1	11·71	2	23·42	9·6	1	2·04	2	4·08
7·1	1	11·21	2	22·42	9·7	1	1·77	2	3·54
7·2	1	10·72	2	21·44	9·75	1	1·64	2	3·28
7·25	1	10·48	2	20·96	9·8	1	1·51	2	3·02
7·3	1	10·24	2	20·49	9·9	1	1·25	2	2·5
7·4	1	9·78	2	19·56	10·	1	1·	2	2·
7·5	1	9·33	2	18·66					

III.—*Continued.*

WRAP TABLE FOR ROVING 30 AND 60 YARDS,

And from 5 to 15 Hanks.

Hank	30 Yards		60 Yards		Hank	30 Yards		60 Yards	
	Dwts.	Grains	Dwts.	Grains		Dwts.	Grains	Dwts.	Grains
1·01	1	0·75	2	1·5	12·6	...	19·84	1	15·68
1·02	1	0·5	2	1·01	12·7	...	19·68	1	15·37
1·025	1	0·39	2	0·78	12·75	...	19·6	1	15·21
1·03	1	0·27	2	0·54	12·8	...	19·53	1	15·06
1·04	1	0·03	2	0·07	12·9	...	19·37	1	14·75
1·05	...	23·8	1	23·61	13·	...	19·23	1	14·46
1·06	...	23·58	1	23·16	13·1	...	19·08	1	14·16
1·07	...	23·36	1	22·72	13·2	...	18·93	1	13·87
1·075	...	23·25	1	22·51	13·25	...	18·86	1	13·73
1·08	...	23·14	1	22·29	13·3	...	18·79	1	13·59
1·09	...	22·93	1	21·87	13·4	...	18·65	1	13·31
1·1	...	22·72	1	21·45	13·5	...	18·51	1	13·03
1·11	...	22·52	1	21·04	13·6	...	18·38	1	12·76
1·12	...	22·32	1	20·64	13·7	...	18·24	1	12·49
1·125	...	22·22	1	20·44	13·75	...	18·18	1	12·36
1·13	...	22·12	1	20·24	13·8	...	18·11	1	12·23
1·14	...	21·92	1	19·85	13·9	...	17·98	1	11·97
1·15	...	21·73	1	19·47	14·	...	17·85	1	11·71
1·16	...	21·55	1	19·1	14·1	...	17·73	1	11·46
1·17	...	21·36	1	18·73	14·2	...	17·6	1	11·21
1·175	...	21·27	1	18·55	14·25	...	17·54	1	11·08
1·18	...	21·18	1	18·37	14·3	...	17·48	1	10·96
1·19	...	21·	1	18·01	14·4	...	17·36	1	10·72
1·2	...	20·83	1	17·66	14·5	...	17·24	1	10·48
1·21	...	20·66	1	17·32	14·6	...	17·12	1	10·24
1·22	...	20·49	1	16·98	14·7	...	17·	1	10·01
1·225	...	20·4	1	16·81	14·75	...	16·94	1	9·89
1·23	...	20·32	1	16·65	14·8	...	16·89	1	9·78
1·24	...	20·16	1	16·31	14·9	...	16·77	1	9·55
1·25	...	20·	1	16·	15·0	...	16·66	1	9·33



Sequence of Machines for Preparing and Spinning Cotton into Ring Yarn.

SECTION III:

RING SPINNING

AND

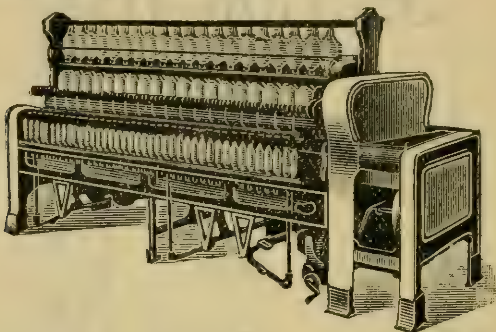
MULE SPINNING

SUMMARIES
OF MACHINES, DRAFTS
PRODUCTIONS, &c.

RING SPINNING:

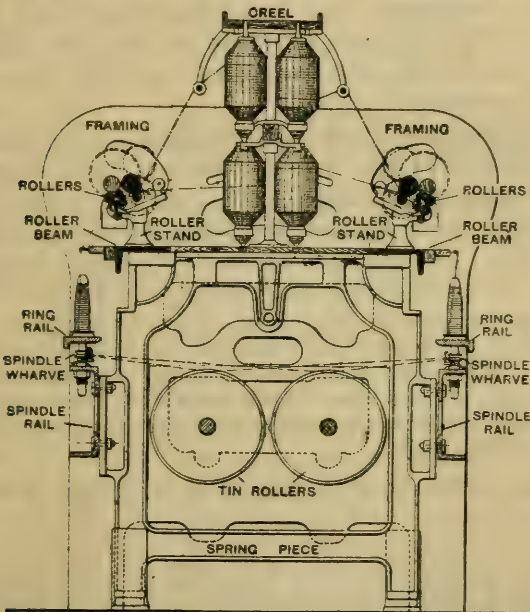
RING FRAME.

Function.—Draws out the rove and spins the same into yarns on the continuous system. The yarn made is usually spun upon bobbins or paper tubes.



Description and Feeding.—The bobbins from the roving frame are placed in a creel in the centre of the frame, being put up either one or two to each spindle, according to the quality of the yarn to be produced. The roving is delivered through traverse guides to three pairs of drawing rollers placed on an angle of 25 to 35 degrees, according to the requirements of the spinner. From the rollers the rove passes through thread-guides placed directly over the centre of the spindle, and is finally wound upon the spindle by means of a ring and traveller. The ring is carried on a movable rail, which rises and falls to give the necessary traverse or lift in building the cop. The spindles—which are carried on "stretchers" or rails of deep section, extending the full length of the frame—are of the "self-contained" type, consisting of a bolster, which is secured to the rail, and carries an inner tube. In this tube the spindle runs. The bolster is arranged so that the bottom part of the inner tube containing the spindle-foot is always immersed in oil. The lubrication is effected by the oil rising up on the spindle-blade, assisted by holes or slots in the inner tube. It is kept constantly circulating over all the bearing parts by the oil running back into the bolster. Sometimes the bolster is provided with an oil cup, which can readily be detached for renewal of the oil. Holding-down catches are provided to prevent the spindle from lifting when removing the finished cops. The spindles are driven by

bands from tin rollers extending the length of the frame. These can be either single or double; the common practice is to have double tin rollers. Separators placed between the spindles are often provided to prevent the threads from "lashing" into one another when starting a new set of cops, or when a large lift or bobbin is being made. These are known as "anti-ballooners," and when used a less space between the spindles can be adopted (usually ⅛th of an inch) in order to get the same size of



bobbin without them. A greater spindle speed can also be run without risk of making much waste, through the ends "lashing" and breaking the others down.

Spindles should be oiled every 2 to 3 weeks to ensure their being properly oiled. A dry spindle will make poor yarn, besides wearing out its bearings and wasting power. New spindles need frequent oiling at the start.

Care should be given to the following points:—

1. That the oil surrounds the bearings.
2. That the bearing shall be of sufficient length to sustain the strain of the band.
3. That the oil is protected from the air and dust.

The bands should be put on with a pull of about 4 lb. They should be tight enough to run the spindle without slipping: if too tight, extra power is taken; if too loose, there will be loss in production and bad yarn will result.

Care should be taken that only stretched banding is used. A special machine is made for stretching banding (described elsewhere: see Index).

Bobbins that are not true should at once be discarded. They should be made of the best material, fitting exactly to the spindles, so that they cannot "creep" or rise.

The cops produced on this machine are sometimes of the straight lift: viz., top and bottom, with taper ends (mostly used for reeling from), or the ordinary cop shape, with short bottom and long taper top, and 5 in. to 6 in. or 7 in. and sometimes 8 in. lift. Creels are made to take either one or two bobbins per spindle.

The machines can be driven either by strap or rope—this latter with specially shaped fast and loose rope pulleys. The fast has two grooves, one of which is shallow and allows the frame to start gradually. The driving may also be by electric motor coupled direct to the tin roller shaft.

Pulleys.—12 in. to 15 in. dia. × 3½ in. to 4 in. wide.

Speed—

Counts at 10's	5,000 revs. of spindle.
Counts at 20's	7,500-8,000 revs. of spindle.
Counts at 25's	8,500-9,000 revs. of spindle.
Counts at 30-40's	9,500-10,000 revs. of spindle.
Counts at 50-60's	9,000 revs. of spindle.

60's Egyptian—about 8,500.

Production—

Counts 10's	55 hanks per spindle.
Counts 20's	50 hanks per spindle.
Counts 30's	45 hanks per spindle.
Counts 40's	40 hanks per spindle.
Counts 50's	35 hanks per spindle.

Hank Rovings Suitable for Various Counts—

Counts 16-18's	from 3 hank roving.
Counts 20-24's	from 3¼-3½ hank roving.
Counts 26-28's	from 3¾-4 hank roving.
Counts 32's	from 4½ hank roving.
Counts 36-44's	from 5-6 hank roving.

Top and Bottom Rollers suitable for Different Kinds of Cotton.

Cottons	Bottom Rollers 1	Bottom Rollers 2	Bottom Rollers 3	Top Rollers 1	Top Rollers 2	Top Rollers 3	Remarks
Indian and Low American	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{3}{4}$	2 and 3 polished, 1 covered.
				$\frac{11}{16}$	$\frac{11}{16}$	1	1 and 2 covered, 3 polished.
Mid. America	1	$\frac{7}{8}$	1	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	All covered.
				$\frac{13}{16}$	$\frac{13}{16}$	1	1 and 2 covered, 3 polished.
				$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{3}{4}$	1 covered, 2 and 3 polished.
Egyptian and Sea Island	$1\frac{1}{16}$	$\frac{7}{8}$	1	$\frac{13}{16}$	$\frac{13}{16}$	$1\frac{3}{4}$	1 and 2 covered, 3 polished.
	$1\frac{1}{16}$	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$	1 and 2 covered, 3 polished.
	$1\frac{1}{16}$	1	$1\frac{1}{16}$	1	$\frac{7}{8}$	2	1 covered, 2 and 3 polished.

Draft.—When single roving is put up at the creel, the draft should not be more than 7 to 7.5, if good results are desired, and for double roving not more than 8 to 8.5.

Spindle Wharves.—1 in. dia. for low counts, $\frac{7}{8}$ in. dia. for twist, and $\frac{3}{4}$ in. dia. for weft counts.

Lift.—5 in., but for low counts 6 to 7 in.

Floor Space.—Width, 3 ft. Length, according to number of spindles in frame.

Rule to Ascertain Length.—Half the number of spindles in frame × space or gauge between spindles. Add 2 ft. 6 in. for gearing and width of driving pulley.

POWER.—A frame containing 344 spindles, spinning 28's counts, with 4/0's traveller:—Spindles only, 1.89 I.H.P., about 55 per cent. Spindles and rollers only, 2.19 I.H.P., about 64 per cent. With bobbins empty, 2.98 I.H.P., about 88 per cent. With bobbins full, 3.28 I.H.P., about 97 per cent. Remaining 3 per cent. absorbed by driving traveller.

H.P. for Ring Frames from actual tests:—

Counts	Gauges	Spindle revs. per minute	Spindles per I.H.P.
36's	$2\frac{5}{8}$ in.	8,500	103
32's	$2\frac{3}{4}$ in.	8,600	100
24's	$2\frac{3}{4}$ in.	9,200	90
20's	$2\frac{3}{4}$ in.	9,000	60
9's	$2\frac{3}{4}$ in.	6,600	77
On Tubes 36's	$2\frac{1}{2}$ in.	9,300	130

Another Test.—In a ring spinning frame, the average of four carefully-conducted tests shows that about 81 per cent. of the power is taken up by the tin rollers and bands, lift motion, rollers and spindles, while about 19 per cent. is required for drawing out the roving by the rollers, friction of the traveller on the ring, of the yarn through the traveller, and overcoming the air resistance.

SPEED VARIATION.—Speed variation in ring frames may be utilised to reduce those tensions on the yarn which are excessive and to bring others which are too small up to a normal value. The speed may be regulated so as to equalise the tensions when spinning on all diameters of the bobbin or to the variable shapes of the ballooning, or it may be made to act on both at the same time.

This equalisation of tension may be aimed at either between the front roller and guide eye or between the traveller and the bobbin, according as to whether more importance is attached to an evenly spun yarn with few breakages or to thoroughly uniform winding of the bobbin. In either case, the application of speed variation increases the output of a frame, and at the same time maintains the quality of the yarn.

Methods.—This variation of speed may be attained in different ways. For instance, in belt-driven frames cone drums may be used or, in lieu of these, expanding pulleys either for belt or rope driving. When the frames are driven electrically by separate motors, a motor of special design and construction is used, which drives the tin roller. The arrangement, which is protected by letters patent, consists in employing an automatic gear in conjunction with the motor. This gear comprises a cam driven by a chain from the heart shaft of the frame. The cam revolves at the same rate as the heart (consequently making one revolution for every up and down motion of the ring rail), and operates a lifting lever. The other end of this lifting lever is connected to the controlling handle of the motor by a steel wire. As the heart revolves, it drives the cam, which lifts the lever up and down, and so varies the speed of the motor, and therefore that of the tin roller shaft.

The speed of the frame is thus controlled in such a manner as to run much quicker when spinning on to the shoulder of the cop or bobbin than on to the small diameter. The tension on the yarn is, as a result, con-

stantly uniform from the nip of the draught rollers. The range of variation in the speed is about 1 in 5.

Positive Spindle Drive.—Dispenses with the use of tin drums and banding in the transmission motion to the spindles. Is positive in its action, and thereby avoids the troubles that frequently arise from banding becoming slack after continuous use. It is worked on the sprocket principle, and consists of an endless flat steel flexible band, which passes alongside the spindles on each side of the frame, and receives its motion from a pulley mounted on a vertical driving shaft at the gearing end. The band is perforated at close intervals to receive suitable projections formed on the periphery of the spindle collars. The system is well adapted for electric driving.

Ring Bobbin Ferrule.—A small piece of tubing, which is inserted round the tapererd hole of conditioning bobbins to prevent the holes from becoming enlarged and the bobbins from going too far down the spindle.

Snarl Catcher.—This simple device consists in the application of a pendant or leg, capable of swivelling freely upon a stud secured to the hinged board which carries the thread-guides. The leg is formed with a number of serrations on either side, and there is one pendant to each spindle. When a snarl is formed on the yarn it is caught in the serrations of the leg before it has time to reach the bobbin. The device is also very effective in preventing what are known as "lashed ends."

Ring Cleaner.—For cleaning and repolishing the rings of spinning and doubling frames by mechanical means, instead of hand-cleaning. Consists of a revolving brush, which receives its motion from the tin roller of the frames. The motion is imparted through a flexible shaft, which carries at one end a friction disc, and at the other end suitable bevel gearing. The brush, which revolves at a high speed, is inserted into the rings, which are quickly cleaned and polished. The apparatus is light, and being portable it can be taken from one frame to another.

Clutches for Rabbeth Spindles.—These ensure the sleeves of the spindles accommodating themselves to any variation in the diameter of the bobbins, and facilitate doffing. The clutch consists of a series of segments inserted into

the sleeve of the spindle, the upper parts of the segments being free to expand radially. The extent of this expansion is limited within an annular space provided by a collar secured to the spindle. The base of the segments rests freely upon a lower collar, which is dished out to receive them. These combined parts form an expanding clutch, so that when the spindle is rotated at its usual speed the centrifugal force thus set up causes the clutch to engage firmly with the inner surface of the bobbin. When the spindle is at rest the clutch is inoperative and the bobbin is loose on the spindle.

Tin Roller Guard and Locking Device.—For preventing accidents to operatives while cleaning down or when applying new bands for driving the spindles of double tin roller frames. Consists of a movable plate extending the length of the frame and fixed in a central position between the tin driving rollers. This plate constitutes the guard proper, and fills in the space between the rollers, with the exception of clearance for the passage of the driving bands. In this position the guard is held secure by a locking device connected with the strap-fork slide of the frame, and while the frame is running. When the machine is stopped and it is desired to replace a band, the act of putting the driving strap on to the loose pulley releases the locking device and allows the guard to be moved clear of the space between the tin rollers to either of the positions. This is effected by moving a small hand-lever beneath the spindle rail and near the first spring-piece of the frame; the direction of the movement is determined by the tin roller to be rebanded. Connected with this lever is a rod, which extends the length of the frame; and as this rod carries at intervals levers connecting with the guard, the guard can be operated from any point alongside the frame.

A form of guard simpler than the above and minus the locking device consists in the application of a light metal frame of triangular form, supported at intervals by uprights. The apex of the triangle projects into the space between the tin rollers, and while the frame is sufficiently close to prevent drawing-in of the fingers, facility in banding is not interfered with, as the form of the construction offers a guide leading the band or cord to one side or the other, as desired.

SEPARATORS OR ANTI-BALLOONERS.

Function.—To prevent the adjacent threads of each bobbin or pirn from lashing against one another and so causing breakages. Also to enable the spindles to be run at higher speeds and to curtail the spindle spacing or gauge of the machines. They also facilitate the use of lighter travellers.

Devices to Attain these Objects.

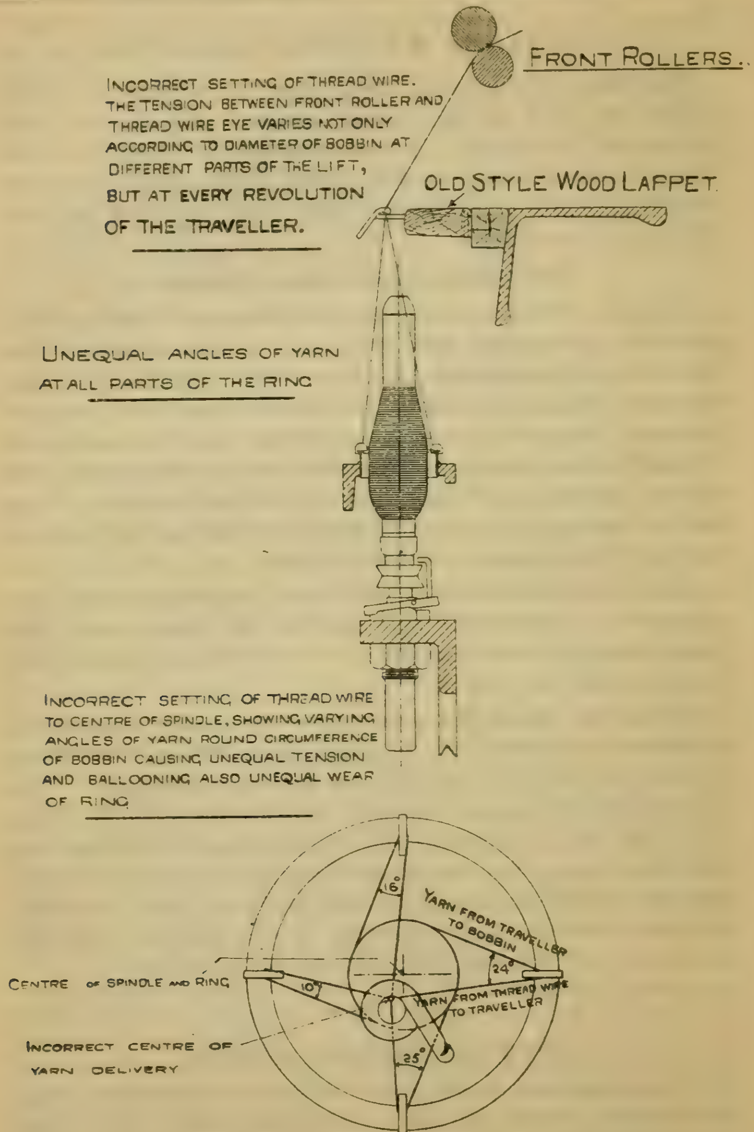
(I.)—In which a wire extends along each side of the machine, behind the bobbins, at a suitable height. The two wires are connected by links with a tightening screw, and are attached to swivelling brackets, so that the distance of the wires from the bobbins can be regulated. When the ring plate has attained a certain height, the wire is automatically released and withdrawn out of the way of the rail. On restarting after doffing, the wire is replaced by means of a hand lever.

(II.)—In the form of "blinkers" mounted upon rods supported in brackets attached to the ring rail. By depressing a lever, the whole series of separators are turned back for doffing.

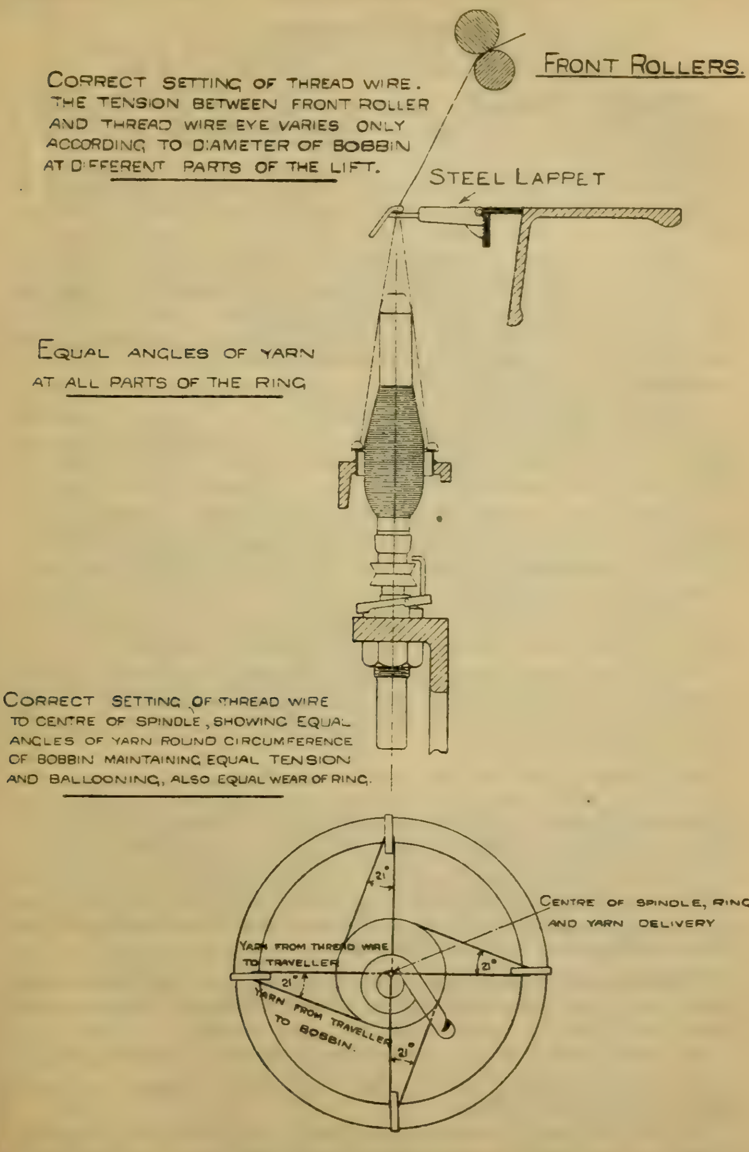
(III.)—In which the separators are made in the form of fingers, curved in such a way as to present a surface of varying height in controlling the balloon. The separators are hinged upon a bar attached to the ring rail, and can be turned out of the way for doffing. In this device any two adjacent separators act on the ballooning at different points: that is to say, one separator operates on the upper portion of the balloon, and the next one on the lower part of the same balloon.

SETTING THREAD-GUIDES.

The diagrams on the two following pages have been prepared by Mr. J. E. Tytler, of Manchester. They show very clearly the effects of correct and incorrect setting of thread guides in relation to the spindles and rings on ring spinning frames:—



INCORRECT SETTING.



CORRECT SETTING.

USEFUL HINTS.

Roller stands should be at an angle of about 25 deg.

Ordinary "Rabbeth" spindles are not suited for speeds above 6,000 revs. per min. Above this speed, use flexible spindles.

Oil-cups to the spindles are an advantage. There is no stopping when oiling, nor waste, and oiling is only necessary about every 12 to 14 weeks.

Variable traverse motions effect a great saving in leathers. A motion to attain its object successfully should so vary the traverse that the path of the guide never starts and finishes at the same place until the cycle of movements has been completed, while the repeat movements should occur as seldom as possible.

Metallic guides should be used on the frames, to ensure concentricity of the thread wires with the spindles and rings. They not only cause better yarn to be spun, but prolong the life of the rings and travellers.

Double tin rollers, 10 in. dia., are mostly used on ring frames, and when positively driven they ensure a uniform speed of the spindle and prolong the life of the driving-bands.

Separators or anti-ballooning motions economise in spindle space and prevent waste. They also facilitate greater production of yarn, and allow the use of lighter travellers.

When the yarn spun has to be rewound, it is a common practice to build the cops with a straight or long lift, as the yarn comes off more freely, and a greater speed can be applied to the reels or swifts.

In spinning fine counts on the ring frame, the output per spindle can be increased by taking advantage of the additional speed admissible after the formation of the cop or bobbin bottom. This is done by applying a two-speed drive frame. The first or slow speed (which is equivalent to the normal speed of a single-driven frame) is used until the cop bottom is formed. The second, or quick speed, comes into action for the remaining portion of the spinning.

Oiling and Cleaning.—The front, bottom, and top rollers should be oiled every two days; the middle and back rollers, along with the tin roller bearings, once a week.

The fluff from the top roller pivots should be removed daily

The fluted rollers should be thoroughly cleaned at least every nine or ten weeks.

The thread-guides should be examined periodically, and (if necessary) adjusted concentrically with the rings and spindles.

The underclearers should be cleared four times a day and the top clearers once a day.

RULES FOR CHANGES OF RING FRAMES.

To find Constant for Twist—

$$\frac{\text{Dia. Tin Roller} \times \text{Carrier Wheel} \times \text{Front Roller Wheel}}{\text{Wheel on Tin Roller} \times \text{circum. Ft. Roller} \times \text{dia. of Wharve}} \Big\} \ 5\%$$

To find Star or Builder Wheel— $\dfrac{\text{Wheel on} \times \text{Counts Wanted}}{\text{Counts Spun}}$

To find Twist— $\dfrac{\text{Constant}}{\text{Twist Wheel}}$

To find Twist Wheel— $\dfrac{\text{Constant}}{\text{Twist required}}$

To find Draft— $\dfrac{\text{Constant}}{\text{Draft Wheel}} = \text{Draft}$

To find Front Roller Speed— $\dfrac{\text{T.R.} \times \text{T.R.W.} \times \text{T.W.}}{100 \times \text{F.R.W.}}$

To find Draft Wheel— $\dfrac{\text{Constant}}{\text{Draft required.}}$

To find Spindle Speed—

$$\frac{\text{Line Shaft} \times \text{dia. of Pulley} \times \text{dia. of T.R.}}{\text{Dia. Frame Pulley} \times \text{dia. of Wharve}} \ \text{less 10\% for slipping}$$

To find Constant for Draft— $\dfrac{\text{Counts} \times \text{Back Roller}}{\text{F.R.W.}}$

To find Twist— $\sqrt[2]{\text{Counts}} \times \text{Constant}$

Constant— 3·5, 3·75, 4·0, 5·5

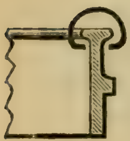
English Counts— French Counts × 1·18

French Counts— $\dfrac{\text{English Counts}}{1{\cdot}18}$

Ring Traveller Magazine.—Prevents ring travellers from bunching or chaining themselves together, thus avoiding waste from this and other causes. The apparatus consists of a magazine arranged to be fixed on a bench or table in any convenient part of the mill. The receiving chamber takes in a bunch of travellers at a time, and by means of internal mechanism discharges them singly upon a receiving table with which it is provided.

When spinning **waste** on the ring frame, the creels and bobbins are dispensed with, and an arrangement is provided for taking in condenser bobbins or cheeses directly from the carding engine.

TRAVELLERS AND RINGS.



Owing to the many conditions that affect Ring Spinning, such as the amount of twist put into the yarn, the draft, the humidity, etc., it is not possible to state the exact size of traveller to be used for any particular counts. The sizes given in the following tables must therefore be taken as approximate only, but will serve as a guide to users:—

Rings.

Double Roving Sea Islands Cotton...		$1\frac{1}{2}$ in. dia.
" Combed Egyptian " ...		$1\frac{1}{2}$ "
" Carded " " ...	$1\frac{5}{8}$ in. to	$1\frac{1}{2}$ "
" Combed American " ...	$1\frac{5}{8}$ in. to	$1\frac{1}{2}$ "
Single Roving Carded American " ...	24's counts	$1\frac{3}{4}$ "
" " " ...	34's "	$1\frac{5}{8}$ "
" " above	34's "	$1\frac{1}{2}$ "
" Indian Cotton	20's "	$1\frac{3}{4}$ "
" "	30's "	$1\frac{5}{8}$ "

Travellers.

To Spin *Egyptian* Cotton.

Rings, $1\frac{1}{2}$ inch diameter. Spindles making 10,000 revolutions per minute. Particulars:—

Combed.		Carded		Combed.		Carded.	
Cts.	Traveller.	Cts.	Traveller.	Cts.	Traveller.	Cts	Traveller
50	8/0 or 7/0	20	5 or 6	76	16/0 or 15/0	46	9/0 or 8/0
52	9/0 or 8/0	22	4 or 5	78	16/0 or 15/0	48	10/0 or 9/0
54	10/0 or 9/0	24	3 or 4	80	17/0 or 16/0	50	12/0 or 11/0
56	11/0 or 10/0	26	2 or 3	82	17/0 or 16/0	52	13/0 or 12/0
58	12/0 or 11/0	28	1 or 2	84	17/0 or 16/0	54	14/0 or 13/0
60	13/0 or 12/0	30	1/0 or 1	86	18/0 or 17/0	56	14/0 or 13/0
62	13/0 or 12/0	32	2/0 or 1/0	88	18/0 or 17/0	58	15/0 or 14/0
64	13/0 or 12/0	34	3/0 or 2/0	90	19/0 or 18/0	60	16/0 or 15/0
66	14/0 or 13/0	36	4/0 or 3/0	92	19/0 or 18/0	62	17/0 or 16/0
68	14/0 or 13/0	38	5/0 or 4/0	94	19/0 or 18/0	64	17/0 or 16/0
70	15/0 or 14/0	40	6/0 or 5/0	96	20/0 or 19/0	66	18/0 or 17/0
72	15/0 or 14/0	42	7/0 or 6/0	98	20/0 or 19/0	68	19/0 or 18/0
74	15/0 or 14/0	44	8/0 or 7/0	100	20/0 or 19/0	70	20/0 or 19/0

When the speed of the spindles is slower than that given above, heavier travellers must be used. Sea Islands cotton requires travellers five to six grades heavier.

To Spin *American* Cotton.

Rings, $1\frac{5}{8}$ to $1\frac{3}{4}$ inch diameter. Spindles making 7,500 revolutions per minute. Standard twist in yarn.

Counts of Yarn.	Nos. of Travellers.	Counts of Yarn.	Nos. of Travellers.	Counts of Yarn.	Nos. of Travellers.
4	16 or 14	22	3 or 2	37	5/0 or 6/0
6	14 or 12	23	3 or 2	38	6/0 or 7/0
8	12 or 10	24	2 or 1	39	6/0 or 7/0
10	9 or 8	25	2 or 1	40	7/0 or 8/0
11	9 or 8	26	1 or 1/0	41	7/0 or 8/0
12	8 or 7	27	1 or 1/0	42	8/0 or 9/0
13	8 or 7	28	1/0 or 2/0	43	8/0 or 9/0
14	7 or 6	29	1/0 or 2/0	44	9/0 or 10/0
15	7 or 6	30	2/0 or 3/0	45	9/0 or 10/0
16	6 or 5	31	2/0 or 3/0	46	10/0 or 11/0
17	6 or 5	32	3/0 or 4/0	47	10/0 or 11/0
18	5 or 4	33	3/0 or 4/0	48	11/0 or 12/0
19	5 or 4	34	4/0 or 5/0	49	11/0 or 12/0
20	4 or 3	35	4/0 or 5/0	50	12/0 or 13/0
21	4 or 3	36	5/0 or 6/0		

To Spin *Brazilian* Cotton.

Rings, $1\frac{3}{8}$ inch diameter, weft turns. Spindles, 6,500 revolutions per minute, 5 inch lift, usual draft.

Counts.	Traveller	Counts.	Traveller.
9	11	28	1
12	10	32	3/0
20	4	40	6/0
24	2		

Rings, $1\frac{3}{4}$ inch diameter, twist turns. Spindles making 7,500 revolutions per minute; 6 inch lift, usual draft.

Counts.	Traveller.	Counts.	Traveller.
16	5	28	1/0
20	3	32	3/0
24	2	36	5/0

RING FRAME OIL MEASURER.

Function.—Measures and supplies oil to ring frame spindle sockets.

Description.—Is usually constructed to hold about 1 quart of oil, and is provided with a vertical force pump, the piston of which is pressed down by the thumb of the operator. An adjusting screw is fixed under the thumb-piece, by means of which the amount of each discharge can be altered. When it is fitted with a sight-feed to the spout, the user can see at a glance that the oiler is doing its work properly.

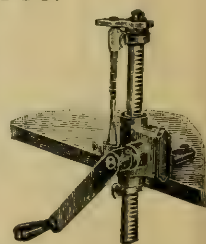
OIL EXTRACTOR.

Function.—Extracts the old spent oil from the bearings of ring frame spindles, and cleans them out before reoiling.

Description.—Is a simple form of pump, the piston of which draws the oil into a chamber. At intervals this is emptied by taking out a screw under the pump handle.

BOBBIN STRIPPING APPARATUS.

Function.—Strips the waste or last few layers of thread from pirns, bobbins, and roving tubes, without injury to the wood of the bobbin.



Description.—The apparatus consists of a rack and pinion, with stripping device fixed to the upper part of the rack. The stripper is provided with movable jaws, which are closed inwards to follow the contour of the bobbin during the time the stripping is taking place.

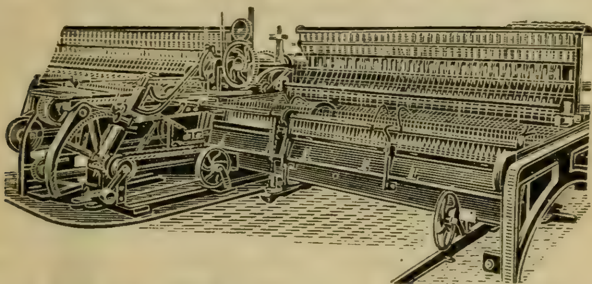
The machine is first adjusted to take in the size of bobbin or pirn by placing the tip of the bobbin into a cup-ended spindle, and the base into the stripper, which gives the length of stroke to be made by the rack during the operation. A stop-collar is then brought up, and is secured in its place by a thumb-screw.

The work of stripping then proceeds, by the operator placing the bobbins, one after the other, in position, closing the stripper with the finger and thumb of the left hand, and turning the handle with the right until the stroke is completed. This apparatus is proving of great service to spinners. This apparatus is also made to work by power.

MULE SPINNING

THE MULE

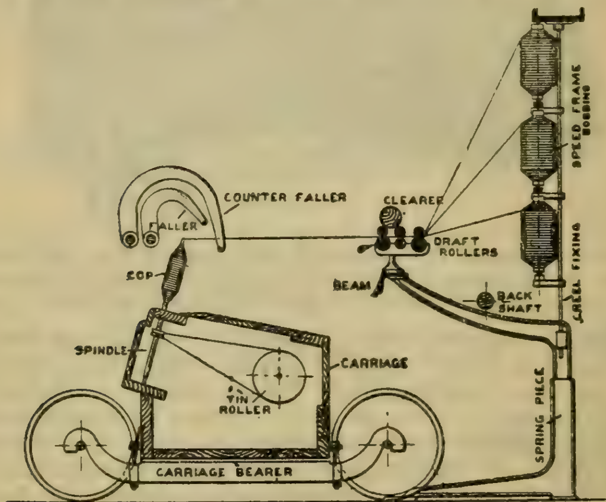
Function.—Spins intermittently. The yarn made is either spun on the bare spindle, or upon short paper tubes when such are required to form a base for the cop bottom. Will spin any counts of yarn required, and is



specially adapted for fine and delicate yarns. It throws in the twist from the spindle point, and thus preserves the elasticity and "cover" necessary for high-class yarns.

Feeding.—Receives the cotton from the Roving Frame, or from the Fine "Jack" Frame when the latter is used in the preparation. These roving bobbins are placed in creels, three or four bobbins in height and in single or double rows, according to the class of yarn being spun. If the yarn is from single roving there is commonly 1 bobbin to a spindle when producing American yarns up to 50's or 60's. Egyptian and better-class yarns are produced from double roving, or 2 bobbins to a spindle. The roving from these bobbins passes over a rod, through guides, and between three pairs of draft rollers, where it is drawn out in the usual way. From the rollers it passes on to the spindles. Between the rollers and the spindles are two wires—the "counter" and the "winding" or "copping" faller wires. The spindles are slightly inclined towards the rollers, the angle varying according to the counts of yarn spun, and being least for coarse counts. The spindles are mounted in a movable carriage, and driven from tin drums, which are also carried on the carriage. The diameters of these tin drums are usually 5 inch for weft and 6 inch. dia. for twist. The spindle wharve varies from $\frac{5}{8}$ inch to 1 inch dia., according to the class of yarn being produced.

The **Operation of Spinning** the roving into thread or yarn comprises the process of elongating and twisting the roving from the previous machine and forming it into thread, and then winding the spun thread into a cop. The twisting is effected by the spindles revolving as though for winding-on the thread, yet at the same time allowing the thread to slip off the spindle point once in each revolution; the fact of the spindle blade being made conical and inclined towards the rollers allows of this slipping off. The result is that the thread



is twisted one turn by each revolution of the spindle, without in any way disturbing or interfering with the yarn already spun and formed into a cop.

In producing the yarn the process may be divided into three operations, namely:—(1) Spinning the Yarn. (2) Backing-off. (3) Winding-on.

Spinning.—During this operation the draft rollers are revolving at their greatest speed; and as the carriage begins to come out or travel away from the roller beam, the spindles are also revolving at their greatest speed and putting in the twist.

The **Backing-off** is the reversing of the direction of the spindles, at a much slower speed than in the spinning operation, and the yarn (which is in spirals on the spindle blade while spinning) is unwound.

The **Winding-on** operation begins by the spindles being again reversed and run at a still slower speed. At this point they are driven through the quadrant, and at the same time the carriage begins to travel inwards towards the rollers; and all the yarn that is between the rollers and the spindle point is wound on to the lower part of the spindle and formed into a cop. The yarn is brought into position by the "counter" faller wire rising and the "winding" or "copping" faller descending; and in so doing one puts a little tension on the yarn and the other acts as a guide to the yarn for the building-up of the cop. After the completion of the inward run of the carriage the fallers resume their original position, and the cycle of operations again commences.

BACKING-OFF CHAIN-TIGHTENING MOTION.—When the carriage is coming out, the "winding" or "copping" faller will be about $1\frac{1}{4}$ inch or $1\frac{1}{2}$ inch higher than the spindle point. The spindles begin to uncoil before the fallers begin to move, which is caused by the tin drums revolving before the backing-off catch can come into play. The spindles have therefore a considerable start of the faller wire, and to get over this it is necessary to have the backing-off chain tight at the finish of the set, so that it may act on the fallers as quickly as possible.

AUTOMATIC NOSING MOTION. This is an arrangement applied to accelerate the speed of the spindles when forming the nose of the cop.

The STRETCHING MOTION (or putting in the "ratch") is to stop the rollers from delivering the yarn, and to impart a slower movement of the carriage just previous to its finishing the outward run. The object is to make the yarn uniform. The thin places receive the greater portion of the twist, thus rendering the weak places stronger and more difficult to be elongated than the thicker parts, which are thus drawn down. The amount of "ratch" introduced varies up to 5 inches, the longest-stapled cotton admitting of most ratch or jacking.

ROLLER DELIVERY MOTION.—This is an arrangement to let out a sufficient amount of roving to relieve the tension when the extra twist is put in the yarn on the completion of the outward run of the carriage.

THE ROLLER MOTION is to allow the rollers to deliver about 3 inches of yarn while the carriage is coming in. Thus a mule of 60 inches draw or stretch actually winds on 63 inches.

MIDDLE DRAWING-OUT SCROLLS are employed for increasing the steadiness of the carriage. They consist of

extra drawing-out scrolls on the back-shaft, in suitable positions in each half of the carriage.

Winding Motion.—To impart increased speed to the spindles just before the inward run of the carriage is completed, so as to wind on any slack yarn and prevent snarls. This motion should be so arranged that it can be made to operate at any distance up to 7 or 8 inches before the completion of the inward run.

Faller Motion.—To take the strain off the yarn, and to a certain extent to prevent snarls.

Double Roving usually produces 10 per cent. stronger yarn than single roving, and the yarn spun is more even.

Double Speed.—To impart increased speed to the spindles when the twisting is taking place in spinning counts about 140's.

Drawing-up Motion.—To regulate the speed of the taking-in of the carriage at any period of the draw and any part of the cop. Applicable when spinning above 120's counts.

Strap-forks of mules should be moved in a parallel line from one pulley to the other instead of radially. There is then less wear and tear on the driving belt, and a deeper strap-fork can be used.

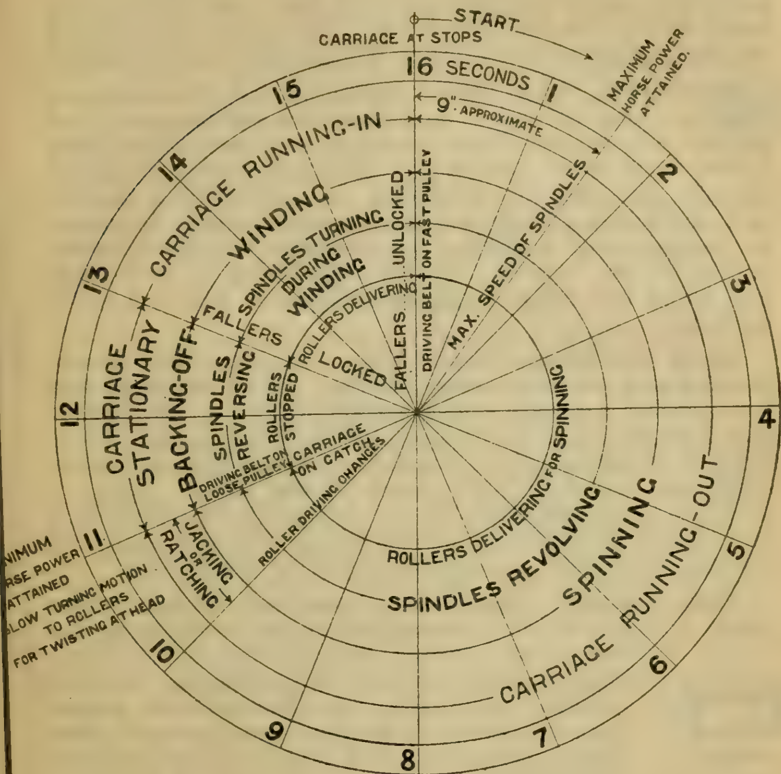
Where extra long mules are employed, the likelihood of the click-motion failing to act can be avoided by duplicating the pawls, thereby obtaining a double purchase upon the teeth of the ratchet wheel at the time of winding. (Patented.)

Faller-stop Guard.—Prevents accidents to the operatives. Consists of a stamped steel sheet, cut and bent to shape with a small detachable ear-piece. This, when secured to the side of the cover by a set-screw, fastens the guard in its place over and around the faller-rods. The stop-fingers are thereby completely encased, and it is thus impossible for an operative to get his fingers trapped at any period of working.

Self-Centring Bolster.—Reduces the power absorbed in overcoming the friction between the spindles and bolsters. The bolster is loosely held in a metal rail, which is firmly secured to the wooden spindle-rail. One side of the bolster is flattened to prevent it from rotating with the spindle. The spindle and bolster adjust themselves to each other automatically.

Grip for Mule Scroll Bands.—Prevents waste in renewing scroll bands. Consists of a small bracket, shaped

(Continued on p. 126.)



The above Diagram is taken, by permission, from a descriptive folder prepared by Messrs. T. T. Hindle and R. W. Whittaker, and published by Marsden and Co., Ltd., at the offices of *The Textile Mercury*, Carr Street, Manchester.

The Diagram represents very clearly the period of a complete Cycle of the Draw of a Cotton Mule, spinning average counts. Time of draw 16 seconds. *Note*: The timing will vary according to the counts spun and the production required of the mule.

out and screwed to the periphery of the scroll. The extended part of the bracket receives two wedge-shaped segments, which together grip the band and prevent its removal by tension or strain. The inner surfaces of the wedges are grooved out to prevent the band twisting.

Scavengers.—Made either in the form of a curtain extending along the mule, and therefore stationary; or of aprons that travel either on wires or ropes. The latter is the form most preferred. This same movement can also be obtained by attaching the apron to a carrier and employing a light rack arrangement, which by means of catches and a tilting bar imparts an intermittent motion to the carrier. On the completion of each journey along the roller beam the motion is reversed automatically.

Metal Carriages.—Metal Mule Carriages are recommended as a precaution against fire. Carriages thus constructed are not only non-flammable, but are also lighter and stronger than wood, more easily cleaned, and not so subject to atmospheric changes. They are also more rigid, and admit of high speeds in the mule.

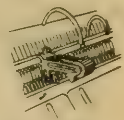
It is estimated that in the ordinary life-time of a mule carriage constructed of wood, its weight is increased between 50 and 60 per cent. by the absorption of oil.

Mule Carriage Stop.—For preventing undue strain upon the yarn by the rebounding of the carriage at the extremity of the outward and inward run.

The device consists of a bracket (secured to the under-side of the carriage frame) provided with an eye-bolt and lock-nut, from which is fulcrumed a lever. At the opposite end of this latter is another bolt for regulating the height of the lever. On the under-side of the lever is a strip of leather, which sets up frictional contact with part of a floor-fixing; means for adjusting the position of the latter are provided by a sliding bracket. The slight friction set up by this combination of parts absorbs the momentum of the carriage just before it reaches the final stop. Six of these stops are required for the outward run of the carriage, and eight for the inward journey.

Tension Attachment.—For applying weight to the fallers only at such times as during the winding-on of the yarn. To increase the length of yarn put upon a cop of given dimensions, and to assist in building a firm cop.

The device consists of a two-pronged lever, in which run the two pivots of a small metal roller. The lever is formed with two curved projections, by means of which it is secured to the counter-faller shaft. As soon as the backing-off is completed and the winding-on commences, the roller gradually rolls down between the two sides of the lever, where it remains until the winding is completed and the fallers unlock. This action tilts the lever over, and causes the roller to run back and assume its inoperative position until the next draw is completed and the backing-off has again taken place.



Power, Production, Etc.

For Indian and Low American......110 spindles to 1 H.P.
For Medium Counts.......................120 ,, ,,
For Fine Counts ....125 to 130 ,, ,,

Pulleys.—16 in. to 18 in. dia. × $5\frac{1}{4}$ in. wide.
Belt from line shaft to countershaft usually 6 in. wide.
Belt from countershaft to mule headstock 5 in. wide.

Speeds.—Pulleys, 650 to 750 revs. per min. for low counts; 850 to 900 revs. per min. for medium and fine.

Production per Spindle.—
The following table is compiled from records of Yarn Production per week of $55\frac{1}{2}$ hours in several modern Lancashire cotton mills.

American Cotton: Single Roving				Egyptian and Sea Island Cotton: Double Roving			
Twist		Weft		Twist		Weft	
Counts	Hanks per Spindle	Counts	Hanks per Spindle	Counts	Hanks per Spindle	Counts	Hanks per Spindle
30	32.16	40	28.9	50	24.37	50	25.69
32	31.55	42	28.7	60	23.4	60	23.5
34	30.95	44	28.5	70	21.52	70	23.12
36	30.55	46	28.3	80	19.28	80	21 54
38	30.38	48	28.1	90	18.0	90	21.3
40	28.8	50	27.5	100	16.8	96	20.5
42	28.3	52	27.1	110	16.1	100	19.8
44	28.0	54	26.6	120	15.4	110	18.9
46	27.5	60	26.0	130	15.0	120	18.19
48	27.8	64	25.6	140	14.8	130	17.6
50	27.0	70	23.7	150	9.6	140	16.6

Rule for Production:—

$$\frac{\text{No. of draws per min.} \times \text{Length of stretch in inches} \times \text{Working hours per week} \times \text{60 minutes}}{\text{840 yards} \times \text{36 inches (or 30,240 inches)}} = \text{Hanks per week} \times \text{Counts} = \text{lb.}$$

Note.—Allowance must be made for cleaning, doffing, etc.—5 per cent. to 7½ per cent., according to counts of yarn and the number of doffings, etc.

Standard Turns per Inch—

American Twist, $\sqrt{\text{Counts}} \times 3{\cdot}75$.

American Weft, $\sqrt{\text{Counts}} \times 3{\cdot}25$.

Egyptian Twist, $\sqrt{\text{Counts}} \times 3{\cdot}606$.

Egyptian Weft, $\sqrt{\text{Counts}} \times 3{\cdot}185$.

Doubling Weft, $\sqrt{\text{Counts}} \times 2{\cdot}8$.

Floor Space.—Width (allowing 64 inches stretch from back to back of headstock of a pair of mules), 20 ft. over all.

Rule to Ascertain Length of Mule with rim pulley at back.—Gauge of spindles × number of spindles in frame. Add space taken up by headstock gearing, which is usually 5 ft. 6 in.

Speed of Spindles and Stretch for Various Counts:—

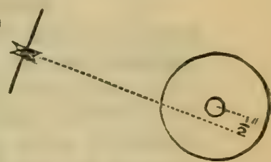
Counts	Revs. of Spindles	Stretch	Draws per min.
6's to 12's	5,000 to 8,000	66 in.	5½ to 5¾
14's to 16's	8,500	66 in.	4¾ to 5
18's to 24's	9,000 to 9,500	66 in.-64 in.	4¾ to 5
30's to 50's	10,000 to 11,000	64 in.	4 to 4½
60's to 80's	9,000	64 in.	3 to 3½
90's to 100's	8,000 to 8,500	62 in.	2½ to 2¾
120's	7,500 to 8,000	60 in.	2¼
150's	7,200 double speed 4,800 single speed	56 in.	2
180's	6,800 double speed 4,500 single speed	54 in.	1·85
200's	6,700 double speed 4,250 single speed	52 in.	1·7
250's	6,250 double speed 3,500 single speed	50 in.	1·4
300's	6,000 double speed 2,700 single speed	48 in.	1

Spindle Lengths, Setting, etc., for Different Counts:—

	Length of Spindle	Length out of Bolster	Diameter of Wharve	Diameter of Tin Roller
For Low Counts Twist ...	18 in.	9 in.	$\frac{7}{8}$ to 1 in.	6 in.
„ Medium Counts Weft	13½ in.	6½ in.	$\frac{5}{8}$ in.	5 in.
„ „ „ „	15½ in.	7½ in.	$\frac{5}{8}$ in.	5 in.
„ Ordinary Twist.........	17½ in.	8¾ in.	¾ in.	6 in.

Spindles usually 13½ inches, but by using 15½ in. spindles for the weft, the spinner can spin what are known as "bastard cops." These are often required for doubling purposes.

In setting mule spindles, see that the driving bands rest upon the lower inclined flanges of the wharves, thereby preventing the spindles from rising in their bearings. *Rule* to be observed:— The centre of the wharve (taken from



the level of the spindle) should point ½ inch below the centre of the tin roller shaft, as shown in diagram Care should be exercised in getting the correct tension on the driving bands. It is faulty to have the bands too slack or too tight.

Bevel of Spindles for Different Counts.

Counts	Bevel with 17½ in. Spindle	Distance from top of bottom roller to Spindle top B
20's-40's	3¾ in.	2¼ in.
40's-60's	4 in.	2⅝ in.
60's-80's	4¾ in.	2¾ in.
80's-120's	5¼ in.	2⅞ in.

For doubling weft ½ in. more.

Pin cops made as doubling weft in proportion to the 17½ in. spindle.

Rollers.—For low counts the rollers are sometimes made 4 threads per boss. Medium counts, American, 3 threads per boss. Fine counts, for good results, should have single boss rollers, but in some districts 2 threads per boss are worked.

For mules (say) over 140 feet long, it is advisable to have the rollers driven in the middle of each side—

this being to overcome the tension and reduce as much as possible the strain in the necks and squares. Also long mules should be provided with middle drawing-out bands and extra taking-in scrolls, to ensure greater steadiness in the carriage.

Diameter of Draft Rollers for Different Cottons.

Cottons	Bottom Rollers 1. 2. 3.	Top Rollers
Indian and low American ...	$\frac{7}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ in. dia.	All $\frac{3}{4}$ in. dia.
American	1, $\frac{7}{8}$, 1 in. dia.	All $\frac{3}{4}$ in. dia.
Egyptian	$1\frac{1}{16}$, $\frac{7}{8}$, $1\frac{1}{16}$ in. dia.	All $\frac{13}{16}$ in. dia., or $1\frac{1}{16}$, $\frac{15}{16}$, 2 in. dia.
Sea Islands ...	$1\frac{1}{8}$, 1, $1\frac{1}{8}$ in. dia.	All 1 in. dia., or $1\frac{1}{16}$, $\frac{15}{15}$, $2\frac{1}{8}$ in. dia.

Draws and Revolutions of Top Rollers.

Revs. per min. of Front Rollers (continuous working) in relation to the number of draws per min. for various diameters of rollers.

Draws	Sec. per Draw	$1\frac{1}{8}$ in.	$1\frac{1}{16}$ in.	1 in.	$\frac{15}{16}$ in.	$\frac{7}{8}$ in.
6	10	197·5	209	222·3	237·1	253·9
$5\frac{7}{8}$	10·21	190	201·17	213·7	228	244·2
$5\frac{3}{4}$	10·43	183·1	193·8	206	219·7	235·4
$5\frac{5}{8}$	10·66	176·2	186·5	198·2	211·4	226·5
$5\frac{1}{2}$	10·9	169·5	179·4	190·6	203·4	218
$5\frac{3}{8}$	11·16	163·07	172·6	183·4	195·68	209·66
$5\frac{1}{4}$	11·42	156·1	165·2	175·6	187·3	200·7
$5\frac{1}{8}$	11·7	150·7	159·5	169·5	180·8	193·6
5	12	144·8	153·3	162·9	173·7	186·1
$4\frac{7}{8}$	12·3	139·1	147·2	156·4	166·9	178·8
$4\frac{3}{4}$	12·63	133·6	141·4	150·3	160·3	171·77
$4\frac{5}{8}$	12·95	128·21	135·7	144·2	153·8	164·8
$4\frac{1}{2}$	13·3	123	130·3	136·3	147·6	158
$4\frac{3}{8}$	13·7	118	124·8	132·7	141·6	151·7
$4\frac{1}{4}$	14·1	112·9	119·5	127	135·48	145·15
$4\frac{1}{8}$	14·5	108·2	114·5	121·7	121·84	139·1
4	15	103·4	109·4	116·3	124·08	132·9
$3\frac{7}{8}$	15·4	98·8	104·2	111·15	118·56	127·02
$3\frac{3}{4}$	16	94·4	100·02	106·2	113·28	121·37
$3\frac{5}{8}$	16·55	90·1	95·4	102·36	108·12	115·84
$3\frac{1}{2}$	17·14	85·94	90·99	96·68	103·128	110·49
$3\frac{3}{8}$	17·7	81·8	86·6	92·02	98·16	105·17
$3\frac{1}{4}$	18·46	77·8	82·35	87·52	93·36	100·03
$3\frac{1}{8}$	19·2	73·9	78·24	83·13	88·68	95·01
3	20	70·1	74·2	78·86	84·12	90·13

An allowance of $4\frac{1}{2}$ secs. is made for the time taken up in backing-off during each draw. The Weighting of the

top rollers varies. For coarse counts all three rows are weighted while the middle and back are self-weighted.

Hank Rovings for Different Counts.

American Single Roving	Hank Roving	Egyptian Double Roving	Hank Roving
Counts 16 to 18	$2\frac{1}{2}$-$2\frac{3}{4}$	Counts 40's to 50's	9-$9\frac{1}{2}$
„ 20 to 26	3-$3\frac{1}{2}$	„ 60's	11-$11\frac{1}{2}$
„ 28 to 32	$3\frac{3}{4}$-$4\frac{1}{4}$	„ 70's	12-13
„ 36 to 44	$4\frac{1}{2}$-$5\frac{1}{4}$	„ 80's	14-$14\frac{1}{2}$
50's w	5	„ 90's	15-16
60's w	$5\frac{1}{2}$	„ 100's	16-17

MULES FOR HOSIERY YARN.

Hosiery yarns are produced on the ordinary cotton mule, and are very soft-spun, as in fine cotton spinning. The conditions under which they are made vary considerably, so that no standard of yarn can be arrived at.

An Example.—Mules to spin 5's to 45's with a spindle speed of 3,000 to 7,500 revs. per min. have a hank roving 1.5 to 7, and the turns per inch from 6 to 20.

Spindles.—$17\frac{1}{2}$ in. to 18 in. long and $8\frac{3}{4}$ in. to 9 in. out of bolster.

Speeds.—Rim shaft, 700 to 750 revs. per min.
Spindles, 3,000 to 8,000 revs. per min.

COP TUBING APPARATUS.

Function.—Supplies the spindles of mules and twiners with paper tubes to form a base for the spun cops. Two (sometimes three) tubers are used for each pair of mules.

Description.—Each apparatus is provided with from 20 to 25 delivery outlets, according to length of mule; the supply magazine is capable of holding 500 tubes at one charge. The outlets correspond in number to the number of chambers in one row of the magazine, and are secured to a plate or door, which at the time of filling is turned back on its hinges. As each row of pockets is filled, the chamber is moved round to bring another row opposite the openings by means of a slide-and-clasp arrangement.

In using the apparatus, the operator places it over the spindles, and, by moving the slide mentioned, liberates the first row of tubes, which fall simultaneously on to the spindles. The operation is repeated over the remaining spindles.

COP TUBE SETTER.

Function.—Presses the tubes down on mule spindles to the required distance, after being dropped thereon by a cop tubing apparatus.

Description.—Consists of a beaded plate, with notches spaced therein to correspond with the gauge of the spindles. Is adjusted by two stop-screws with lock-nuts, which come into contact with the spindle-rail.

SPINDLE FOOTSTEP PROTECTOR.

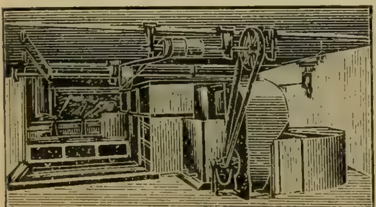
Function.—Protects the footsteps of mule spindles from dirt and fluff, and the oil from running down the spindle-rail at the time of oiling.

Description.—Is formed in one continuous rail, so as to cover the line on which the spindle footsteps are fixed, each individual protector being enclosed within the rail.

YARN CONDITIONING MACHINE.

Function.—Applies moisture to yarn in hanks, cops, or on ring frame bobbins, by mechanical means, in definite quantities, and without having to depend upon atmospheric conditions.

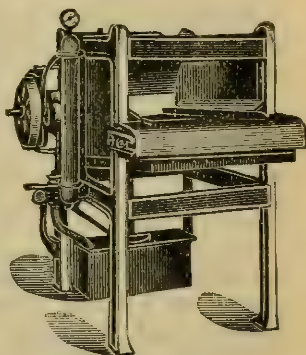
Suction System.—For use instead of conditioning cellars, in dealing with large quantities of yarn, either in the cop, cheese, or on ring frame bobbins, in skips or cans, as the yarn comes direct from the spinning room. The receptacles containing the yarn are placed (in batches of six) in hollow wagons, formed with a corresponding number of openings, which admit of their reception to about half their depth. When the wagons are fully charged they are run into chambers, of which there



are usually three to a machine. Connected with these chambers are inlet and outlet ducts or tubes, the ex-

treme ends of which join a casing containing a powerful fan. This fan performs the twofold function of blower and exhauster in causing air to be circulated through the chambers. Before entering the chambers, the blast of air created by the fan encounters an " atomiser," which receives and breaks up a combination of steam and water supplied by an injector, and thereby imparts to the air the requisite amount of moisture to be taken up by the yarn.

The chambers having been closed and the connections made, the action of the fan forces the air containing the moisture into the chamber, in the form of a fog-like spray, and at the same time draws or sucks it through the cops. These, acting after the manner of pressure filters, retain the moisture, and allow the air to escape.



Spraying System. — The material to be operated upon is placed on a travelling apron, which passes under a humidifier, consisting of two spraying nozzles. These nozzles are each provided with small propellers, in which spiral grooves are cut. The water, passing through the grooves under pressure, is caused to revolve very quickly, and is discharged from the nozzle in the form of a fine spray. The water is drawn from a tank through a sieve by means of a power pump, and is discharged into a chamber. While still under compression, the water in this chamber is sent through the sprayer. All water not taken by the material flows back into the supply tank, to be used over again. The material passes through the machine continuously, and after receiving the proper degree of moisture is deposited into a skip or other convenient receptacle. The amount of moisture is regulated by means of change-wheels between the driving wheel and the lattice roller wheel. **Production.**—3,000 lb. per day.

Pulley.—15 in. × 2 in.; speed, 100 revs. per minute.

Floor Space.—4 ft. × 3 ft. **Attendance.**—One youth.

Tank System.—The yarn is placed in wire cages and lowered into a tank of water. Having absorbed sufficient moisture, the cages are taken to a well-ventilated store-

room to "mature" by the moisture distributing itself throughout the bulk.

Vapour System.—The machine consists of a series of trays, supported at the extremities of the spokes or arms of wheels, which revolve. The yarn is placed in the trays, which are carried round in a circular path by the revolving of the wheels. As the trays reach the lowest path, they pass over and close to a trough of warm water. From this rises vapour, and the moisture thus percolates through the fibres.

DRAFTING:

DRAFT IN COTTON MACHINES.

Draft in Cotton Preparing and Spinning Machines is measured by the relative lengths of cotton fed and delivered in a given time.

The amount of draft in a machine may be ascertained by dividing the surface speed of the delivery roller by that of the feed roller. Thus, in a scutcher, if the surface-speed of the feed-roller be 56½ inches per minute, and that of the lap-roller 249 inches per minute, the draft is 249 ÷ 56.5 = 4.4.

As in all cotton machines there is a direct connection between the feed-roller and the delivery-roller (by means of toothed wheels or by means of pulleys), it follows that the relative speeds of these rollers may be obtained. Suppose Fig. 1 to represent a simple machine, A being the feed-roller and B the delivery-roller. On A is a wheel C, of 20 teeth, driving D of 10 teeth on the delivery roller:—

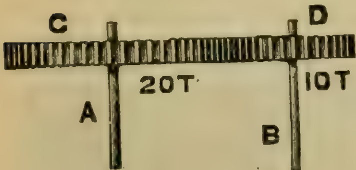


Fig. 1.

The calculation is made by multiplying the revolutions of A by the number of teeth in C, and dividing by the number of teeth in D. Thus, $1 \times 20 \div 10 = 2$. If the circumference of A is equal to the circumference of B, the surface speed of B will be twice that of A, and therefore the draft in the machine will be 2.

If A and B are each 2 inches in circumference, the surface speed of B equals $20 \times 2 \div 10$. By dividing the surface speed into that of the delivery, the result is—

$$20 \times 2 \text{ in.} \div 10 \times 2 = 2 \text{ draft.}$$

As the rollers in the machines are sized in diameters, the calculation (so far as draft is concerned) can be made without working out the circumferences. Referring again to Fig. 1. If A is 2 in. diameter, and B 8 in. diameter, the draft will be—

$$\frac{20 \times 8 \text{ in.}}{10 \times 2 \text{ in.}} = 8$$

All draft calculations may be solved on the above basis.

In the following machine the draft would be—

$$\frac{60 \times 40 \times 2 \text{ in.}}{30 \times 20 \times 3 \text{ in.}} = \frac{8}{9} = 2\tfrac{2}{3} \text{ draft.}$$

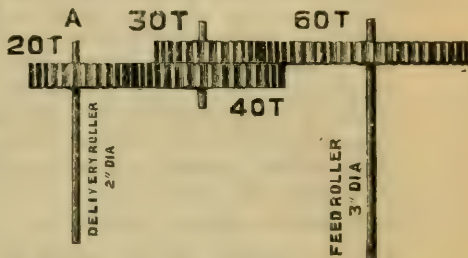


FIG. 2.

Or, if the change-wheel A be required to give a draft of $2\tfrac{2}{3}$ substitute the draft for the number of teeth in A, thus:—

$$\frac{60 \times 40 \times 2}{30 \times \underset{\text{draft}}{2{\cdot}6} \times 3} = \frac{160}{7{\cdot}8} = 20 \text{ teeth in A, required.}$$

Fig. 3 represents the principle as applied to a Carding Engine. In this case the draft between the feed-roller and doffer would be—

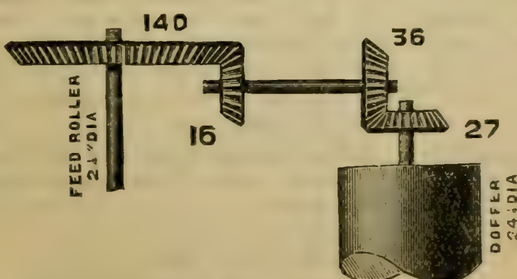


FIG. 3.

$$\frac{140 \times 36 \times 24{\cdot}75 \text{ in.}}{16 \times 27 \times 2{\cdot}25 \text{ in.}} = \frac{11{\cdot}55}{{\cdot}09} = 128{\cdot}3 = 128\tfrac{1}{3} \text{ draft}$$

between feed-roller and doffer.

In a Scutcher of the following particulars—

Feed roller, $2\frac{1}{4}$ in. diameter.
Wheel on end, 55 teeth.
Gearing with worm wheel pinion, 45 teeth.
Worm wheel, 65 teeth.
Gearing with a single worm on top cone shaft.
Cones on equal diameters.
Bottom cone drum wheel, 24 teeth.
Driving a 48's pinion on side shaft.
On other end of side shaft a 20's bevel.
Gearing with a 30's bevel on bottom cross shaft.
On other end of cross shaft a 13's wheel.
Gearing with a 65's wheel on drop shaft.
Also on drop shaft a 20's pinion for driving lap rollers.
Gearing with a 71's wheel compounded with a 17's wheel.
This latter drives a 30's lap roller wheel on the end of the lap roller.
Lap roller, $8\frac{3}{4}$ in. diameter—

the calculation would be as under:—

$$\frac{55 \times 65 \times 24 \times 20 \times 13 \times 20 \times 17 \times 8{\cdot}75 \text{ in.}}{45 \times 1 \times 48 \times 30 \times 65 \times 71 \times 30 \times 2{\cdot}25 \text{ in.}} = \frac{1701{\cdot}7}{517{\cdot}59}$$
$$= 3{\cdot}3 \text{ draft of scutcher.}$$

If, in a Scutcher, the weight of feed per yard is 48 oz., and the weight of delivery 12 oz., the draft would be four, if no waste were taken out by the machine. But, as all machines take out waste, it is impossible for the 48 oz. of feed to be drawn out into four yards of 12 oz. each. If, therefore, the Scutcher is taking out 4 per cent. waste, all that can be obtained from 48 oz. is 96 per cent. Calculate accordingly. Thus:—

$$\frac{48 \times 96}{12 \times 100} = \frac{384}{100} = 3{\cdot}84 \text{ draft.}$$

Or, in a Card, if the lap is 12 oz. per yard, and the sliver 60 grains per yard, with 8 per cent. waste, the draft would be 12 oz., or—

$$\frac{\overset{\text{grains}}{5250} \times 92}{\underset{\text{grains}}{60} \times 100} = \frac{161}{2} = 80{\cdot}5 \text{ draft.}$$

This would, of course, be the draft over all, and must not be confused with the draft between feed-roller and doffer in Fig. 3.

This method is certainly much simpler than that first explained, but of necessity it cannot be so accurate, as all the factors in the calculation—that is, weights and amount of waste—are estimates only.

These principles apply to all cotton machines, and may be illustrated by the Mule or Roving Frames as well as by the examples quoted.

Alteration of Draft.

In altering the draft of preparing and spinning frames the change should not be restricted to the 1st and 2nd rollers for the total, but the difference should be distributed over the 2nd and 3rd, and in the case of drawing frames with four pairs of rollers to the 3rd and 4th.

Assuming that the three drafts in the 1st head of drawing are 1.2, 1.36, and 3.16 respectively, giving a total of 4.82, and it is required to get a total draft of 5.50 at the 2nd head, the following rule is observed:—

Find the ratio of the two total drafts by dividing one by the other. Extract the cube root of the quotient and multiply the three former drafts by the square root thus found; the result will be the three respective drafts to suit the new total. Thus—

$$\text{Let } x = \text{ratio, then}$$
$$1.12x \times 1.36x \times 3.16x = 4.82x^3,$$

and from this equation results—

$$4.82x^3 = 5.50 \text{ or } x^3 = \frac{5.50}{4.82} \text{ or } x = \sqrt[3]{\frac{5.50}{4.82}}$$

By multiplying the three drafts in the 1st head by this value of x, the product is 5.50 draft in 2nd head.

NOTE.—It should be noticed that when the total draft is decreasing, or the counts are being made coarser, the former three drafts must be divided by the root as found above, and the result will be the same. For frames with three rows of rollers the same rule applies, except that the ratio of two drafts only is taken into account.

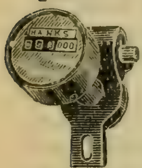
By adopting the above rule the finished yarn is stronger and more even; and the breakages are fewer because the ratio of speeds of all the cotton fibres is maintained through each pair of rollers down to the delivery of the rove on the spinning machine, whether mule or ring frame.

Setting Device for Draft Rollers.—To ensure accurate spacing and true alignment with the bottom rollers. Consists of a frame to which are secured guide-pieces to fit over the rollers. The guide-pieces have attached thereto short bars, which run at right angles, and at their outer ends have conical pieces fitted. Springs are threaded on the bars to retain them in position. Centre dots on the neb setting pieces are equivalent to the distance from centre to centre of the corresponding fluted rollers.

HANK INDICATORS.

Function.—To register the number of hanks passing over the front rollers of draw frames, speed frames, and ring frames.

Description.—The number of hanks and the decimal parts of each hank are indicated in plain figures on the surfaces of revolving discs in front of the instrument. It is arranged to register up to 100 hanks; or, when desired, it can be made to show either metres or revolutions. The principal working parts are few, merely consisting of a coarse-pitch worm-and-wheel, and a pinion connected with each disc.



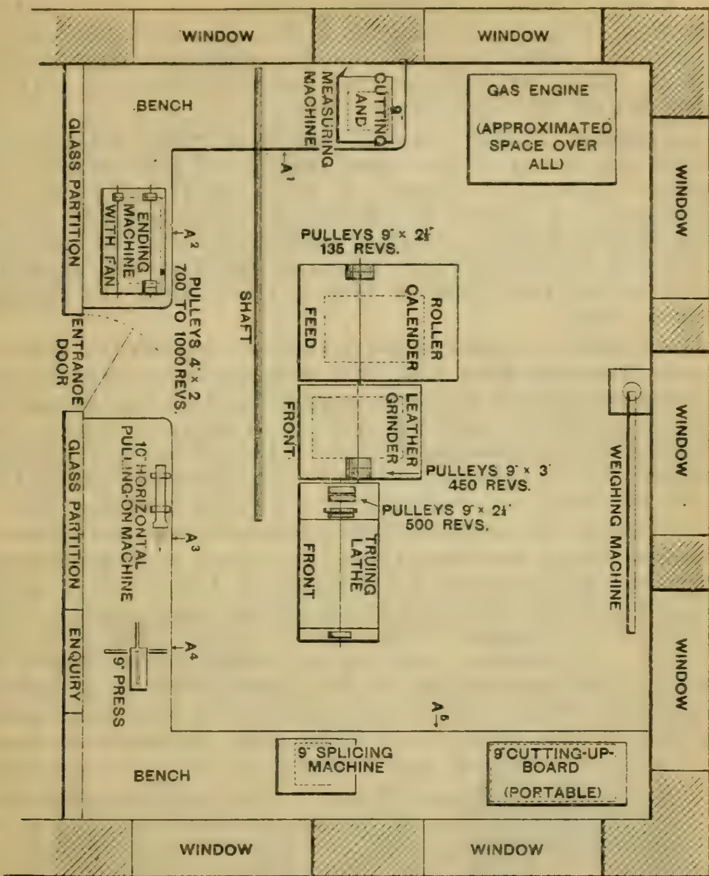
COVERING DRAFT ROLLERS

MACHINES & APPLIANCES.

No cotton-spinning mill of to-day can be considered fully equipped that does not possess a complete installation of machinery and appliances for covering and otherwise finishing off the top drawing rollers of preparing and spinning frames. The antiquated method of using primitive tools and appliances is being discarded and machinery of delicate construction now takes its place.

The complete series of machines and appliances used should consist of the following:—

Cloth Covering Machine.
Leather Cutting Board.
Leather Grinding or Equalising Machine.
Leather Splicing or Bevelling Machine.
Leather Piecing Press.
Leather Tube Pulling-on Apparatus.
Roller-ending Machine.
Calender for Finishing Rollers.
Truing and Varnishing Machine.
Roller Testing Machine.



Plan of a Complete Installation of Roller Covering Machinery and Appliances.

The space below the benches utilised as follows:—

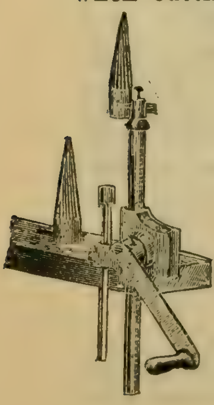
A1. Stock-cupboards with sliding doors.
A2. Open shelves to carry rollers for ending.
A3. Drawers to hold cut leathers, hots, and implements.
A4. Open space to serve as kneehole for operator when seated.
A5. Rack-drawers for rollers.

CLOTH COVERING MACHINE.—Takes the cloth in the form of strips of a definite width, passes it through a paste-box, measures and cuts the cloth into lengths and by a rolling action fixes the cut piece into its correct position on the boss of the roller.

LEATHER CUTTING BOARD.—Is used when cutting the skins into strips of the correct width. It is provided with adjustable stops by the side of which measuring plates are inserted. A planed straight-edge or bar extends across the board, with the cutting edge close to a slot for the knife to enter. The bar is raised to allow the skins to pass under, then lowered to grip them when the cutting takes place.

GRINDING OR EQUALISING MACHINE.—Grinds the leather strip from the flesh side, just sufficiently to equalise its thickness without any undue waste of fibre and strength. The machine is provided with a drum, over which the leather strip is passed. Whilst on the drum the surface is ground by a glass-covered roller. The fibre and dust taken off the leather are removed by a quickly revolving fan.

SPLICING MACHINE.—This machine takes the ground leather strips and cuts them into pieces of the required size and at the same time bevels off the edges so as to make a perfect joint when the piecing takes place. The leathers are passed between feed rollers (flesh side up) which, by revolving, give off a predetermined length of strip. The piece is cut off by a knife held in a sliding carriage, which moves across the machine. The knife when cutting, slides on a glass plate to ensure a clean cut of the leather.



PIECING PRESS.—Presses the two bevelled edges of the pieces of leather together so as to form a tube or "hot" for drawing over the bosses of the rollers. When the press is provided with a turntable the tubes can be prevented from sticking together after pressing.

PULLING-ON APPARATUS.—Draws the tube or "hot" on the roller over the cloth and can be worked vertically or horizontally. The roller to be covered is held in a countersunk stud; and, by means of a series of fine springs joined together, the leather is drawn gently into its place on the roller, and the necessary movement is obtained by turning a handle which operates a pinion and rack.

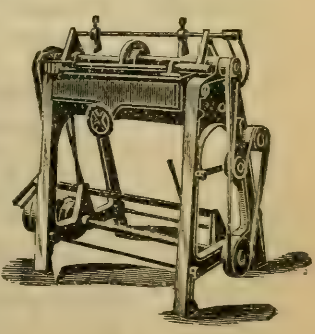
For drawing on the leather "hots" or sleeves upon rollers of small diameter, such as are used in mules and combers, a special apparatus is now made. It consists of a hand lever and toothed rack, which work in conjunction with suitable gear-wheels enclosed in a box. It is only necessary to pull the hand lever forward to ensure the sleeve being drawn uniformly on to the roller.

By means of a cap-and-collar arrangement the use of solder in securing the springs together may be done away with. The improvement imparts greater resilience to the wires, and facilitates the replacement of bent or damaged ones.

Roller Ending Machine.—Is the first machine employed in the finishing process, and is used in turning down the superfluous leather, which projects beyond the surface of the boss. The machine consists of a polished cylinder, which revolves at from 700 to 1,000 revs. per minute.

Calendering Machine.—In this machine the rollers are calendered between hot surface plates and improved in many ways. Not only are flat places, scaly surfaces, and other imperfections removed, but a high polish is imparted to the leather surface.

Truing and Varnishing Machine.—For grinding and varnishing the rollers of combing machines; may also be used for putting into working condition rollers that are not sufficiently worn to require recovering. The grinding disc is worked on the traversing-wheel principle, and is covered with a specially-made grinding tape, which can be readily replaced when worn. The rollers to be ground are mounted in adjustable chucks, and the machine is set to operate on different lengths of rollers by means of movable stops. A hand-wheel and screw is provided for bringing the rollers up to the grinding disc.



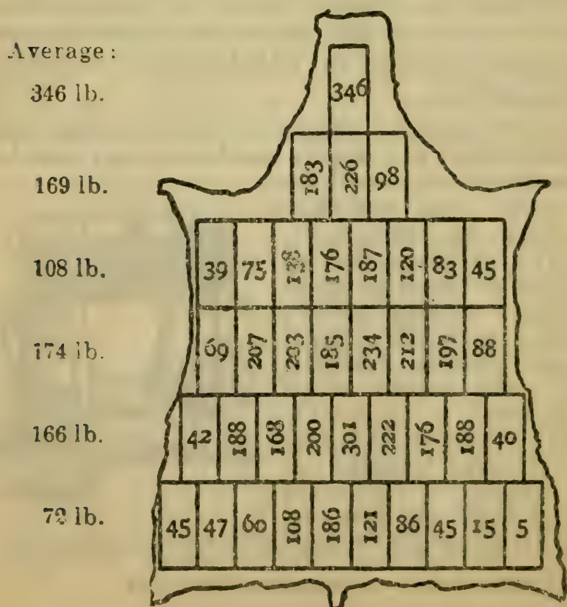
Pulleys.—9 in. × $2\frac{1}{2}$ in. **Speed.**—500 R.P.M.

Floor Space.—4 ft. 6 in. × 2 ft. 0 in.

Testing Apparatus.—This is the last of the series and by its use the surface of the rollers can be tested and any irregularity therein discovered. The apparatus consists of two bars or plates one above the other, and having absolutely parallel surfaces. The upper plate is suspended to rise and fall any distance required by the diameter of the roller. The bottom plate is grooved to receive the roller and keeps it in position for testing. The test is made by allowing the upper plate to fall upon the surface of the roller and by the aid of a strong light at the back: the tester bar will show spaces if any irregularity exists in the covering of the roller.

Breaking Stresses.—The accompanying Diagram shows the breaking stresses of the various portions of a roller leather pelt.

Average breaking stress for a whole skin—136 lb.



DURATION OF LEATHER-COVERED ROLLERS.

In a mill spinning, say, 56's counts, and where the rollers are kept in first-class condition, they last the following periods:—

Drawing Frame front rollers	3	months.
,, middle and back rollers	5	,,
Slubbing, Intermediate, and Roving Frame front rollers	6	,,
Slubbing, Intermediate, and Roving Frame middle and back rollers	8 to 9	,,
Ring Spinning Frame Rollers	6 to 8	,,
Mule rollers	4 to 8	,,

The above are approximate and would vary with different counts, quality of cotton, etc. They are, however, taken from the working of a modern mill using pelts and roller cloth of good quality.

By using the latest variable traverse motions, the above periods may be considerably increased.

In another mill, of 65,000 ring spindles, spinning 30's to 46's twist, and 28's to 46's weft—

Slubbing Frames, ½ hank roving	11 to 12	months.
Intermediate Frames, 1-2 hank roving	7 to 8	,,
Roving Frame, 5 hank roving	10	,,
Ring Frame—Twist	7 to 8	,,
,, —Weft	6 to 7	,,

Pelts used: No. 3 and No. 4, sizes 28×22 and 26×21 respectively.

Roller cloth will generally last about three leather coverings.

By an improved method of tanning and finishing, roller leather can be produced that is impervious to moisture, and does not require the coating of varnish applied under ordinary conditions to prevent "licking."

VARIABLE TRAVERSE MOTION.

Function.—To effect a saving in the leather covers of draft rollers, by so varying the traverse of the rove-guides of flyer and ring frames that the path of the

guide never starts and finishes at the same place until the cycle of movements has been completed, while the repeat movements occur as seldom as possible.

Description.—The apparatus is encased within two circular covers, one of which is secured to an ordinary angle-bracket fixed to the roller-beam of the frame. This latter forms the outer rim of an internal-toothed wheel, central with which is the bearing for the driving stud of the motion. This stud is caused to revolve by a worm-and-wheel from the back draft roller of the frame. The front end of the stud is formed as an eccentric, and carries a free wheel, the teeth of which engage with those of the internal wheel. For each revolution of this

eccentric the wheel that it carries makes a further partial revolution on the axis of the eccentric, proportionate to the difference in the number of teeth in the two wheels. Formed on one side of this wheel is a second eccentric, which carries a strap and connecting-rod, for imparting the necessary reciprocating motion to the rove guide rail.

RECIPES AND NOTES.

Paste for Cloth :—

3 lb. best Austrian flour.

3 lb. amber resin, crushed into fine powder.

3 tablespoonfuls of Venice turpentine.

(1) Place the flour in 1½ quarts of water and steep several hours before making the paste.

(2) Place the resin in a pan with 1½ quarts of boiling water, continue to boil for 25 minutes, then add turpentine and boil another five minutes. Add the steeped flour and boil all together, continually stirring to thoroughly mix the ingredients.

A little boiled oil may be added to the above, but its use prevents quick drying.

Cement for Leather Cots or Tubes :—

Take 3 oz. fine gelatine, soak in 4 fluid ounces rain or distilled water, stir frequently until soft; then boil, stirring rapidly until the whole is dissolved. When cold, the cement is solid; for use it must be melted, and applied hot.

Cement for Piecing Leathers :—

Acetic acid and isinglass, about equal quantities of each.

Roller Varnish :—

Take 1 lb. chrome yellow, and mix with ¼ lb. lamp black and ¼ lb. rouge. Roll well with a roller to take all the small lumps out. Take 10 oz. joiner's glue, and boil it in two quarts of water; add to the above, and let it simmer for half-an-hour, continually stirring it. If it should be thicker than ordinary paint, dilute with warm water, and bottle. Before using, this varnish should be slightly warmed.

Roller Coverer's Requisites :—

Pair of Scissors.
Paste Knife.
Stripping Knife.
Combined Callipers and Compasses.
Oil Stone.
Rough Stone.
Cranked Knife.
Glue Kettle.
Glue Brush.
Chisel.
Two-foot Rule.

Slack covering causes excessive wear in the leathers.

The quality of yarn spun is affected by the leather-covered rollers.

Never tear the cloth into strips, but cut the edges clean down with a sharp knife.

Cloth 27 in. wide and weighing from 16 to 20 oz. per yard is usually employed for the rollers.

Roller skins should never be cut into strips across the hide, but lengthways from head to tail, which is the direction of the growth.

Badly-covered rollers are a source of expense, they need frequent recovering. Roller cloth should be firm and springy, evenly woven and well milled.

Rubbing or fluted rove may arise from the top (leather-covered) roller and the bottom (fluted) roller being of the same diameter. After a time they tend to work together like a pair of toothed wheels. Or it may be due to the cushion effect of the cloth having been destroyed.

Self-lubricating Weight Hook.

Function.—To dispense with oiling by hand the necks of the draft rollers; to save lubricant; and to prevent damage to cotton by oil spots.

Description.—Is provided with a small chamber for the reception of grease, which is supplied every four or five weeks. A lid is fitted over the chamber to keep out dust and dirt, and a projecting shield excludes dust from choking up the outlet for grease.

APPROXIMATE COSTS AND COMPARISONS IN A MULE AND A RING SPINNING MILL.

THE COST OF BUILDING, INCLUDING BOILER AND ECONOMISER SEATINGS, ENGINE FOUNDATIONS, AND CHIMNEY.

Estimated cost per supl. foot of floor space occupied by mules for above for average 40's = about 4/- per foot.
Estimated cost per supl. foot of floor space occupied by ring frames for above on average 40's.. = about 4/6 per foot.

Power required for Ring Frames over Mules = 20% extra.

Floor Space for Ring Frames, including passages $2\frac{1}{4}$ gauge = ·633 sq. feet per ring spindle.

For Mules, including passage $1\frac{1}{8}$ gauge = 1·11 sq. feet per mule spindle.

PROPORTION OF FLOOR SPACE, RINGS *v.* MULES (WEFT).

Nos. Ring System	Sq. feet per spindle	Total	Nos. Mule System	Sq. feet per spindle	Total
24's Cardroom	·9	=1·52	25's Cardroom	·66	=1·65
Spinning	·62		Spinning	·99	
23's Cardroom	1·0	=1·66	22's Cardroom	·76	=1·76
Spinning	·66		Spinning	1·0	
35's Cardroom	·92	=1·59	34's Cardroom	·55	=1·65
Spinning	·67		Spinning	1·1	
36's Cardroom	·8	=1·51			
Spinning	·71				
50's Cardroom	1·1	=1·79	50's Cardroom	·73	=1·93
Spinning	·69		Spinning	1·2	

Below is given approximately the proportion of machines in relation to each other for various counts, also the horse-power for spinning spindles, including preparing machinery:—

Mule Spindles.

	Single Roving						Double Roving					4 Sets Speed Frames		
Counts............	10	10	20	30	40	50	60	70	80	90	100	80	95	100
1 Card........................	300	300	555	800	1,050	1,111	1,176	1,111	1,176	1,250	1,333	1,250	1,428	1,428
1 Finished delivery ...	333	333	625	869	1,176	1,250	1,333	1,333	1,539	1,428	1,538	1,538	1,666	1,539
1 Slubbing spindle......	27·6	49	72·7	87	103	113	129	134	121	135	123·4	178·5	243	263
1 Intermediate spindle	—	23	33·6	32·9	40	47·7	32·8	35·7	40	45·4	34	77·8	94	102
1 Roving spindle.........	11·26	11·26	14·5	10·5	12·5	15·5	9·12	9·29	9·3	9·9	7·2	27·8	30·8	31·3
2nd Roving spindle ...	—	—	—	—	—	—	—	—	—	—	—	8·75	7·2	7·29
1 h.p. = to spindles and preparation ...	47	45	55	60	64	66	63	66	68	68	66	67	67	67

Ring Frame Spindles.

	Single Roving								Double Roving	
Counts............	10	10	20	30	36	40	45	50	55	60
1 Card	175	175	371	520	655	765	800	800	645	550
1 Finished delivery	185	190	415	580	714	833	870	909	714	620
1 Slubbing spindle	12·7	21·16	46·5	58·6	60·9	59·7	71	84	45·2	42·2
1 Intermediate spindle	—	9·8	18·46	22·17	23·3	25·38	28	32·8	15·8	15
1 Roving spindle	5·49	4·6	6·2	6·17	6·95	6·7	7·29	7·1	3·8	3·5
1 h.p. = to spindles & preparation	33	38	42	46	48	50	51	54	45	43

TESTING OF SPINNING, &c., MACHINES

POWER TESTS OF PREPARING AND SPINNING MACHINES.

Tests made by Transmission Dynamometer.

By Mr. Clement J. Charnock, of Sereda, Russia.

The following table shows the power absorbed by a Roving Frame containing 164 spindles, before and after the machine has been squared up by the mechanic :—

Power Absorbed by Roving Frame.

Sort and Classification of Cotton	Hank Roving produced	Speed of Frame Shaft, revs. per min.	Number of Spindles	Revolutions of Spindle per minute	Revolutions of (1¼ inch) Front Roller per min.	Turns per inch of Rove	Indicated H.P. with Lift on Top	Indicated H.P. with Lift on bottom	Average Indicated Horse Power
4th Texas G.M.	4.63	372	164	1060	112.3	2.4	2.00	2.30	2.15
4th Texas G.M.	4.63	376	164	1072	113.5	2.4	1.50	1.54	1.52

A difference of 29.3 per cent. is thus shown in the average indicated horse-power.

From the foregoing, it is deduced that by far the most common and serious cause of heavy running of frames is the lifting mechanism. This, when not travelling in a correct vertical line, binds the spindles, especially in its lower positions. It also puts extra strain on the cone belts—to the detriment of the winding.

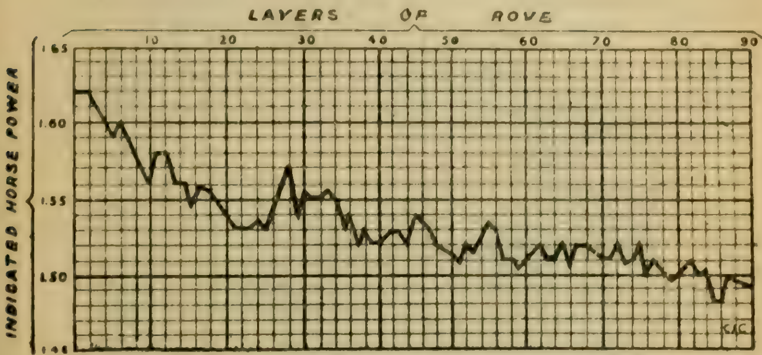
Power Absorbed by Set of Bobbins.

The Diagram on next page shows the power absorbed from the beginning to the end of a set of bobbins. It will be seen therefrom that the power decreases considerably until after the 35th row of rove, after which the diminution is more gradual.

This irregular variation conforms to the shape of the cone drums, and is caused by the necessary decrease in speed of the bobbins and lifter rail as the bobbins enlarge. The sudden rise of the line between the 25th and 35th row was accounted for by an accumulation of "fly" in

the delicate mechanism of the dynamometer, which impeded its action. It will be observed the Diagram indicates that the decrease of power due to slower speed of the bobbins as they decrease in diameter is

$$\left(100-\left(\frac{100 \times 1.49}{1.62}\right)\right) = 8\%$$



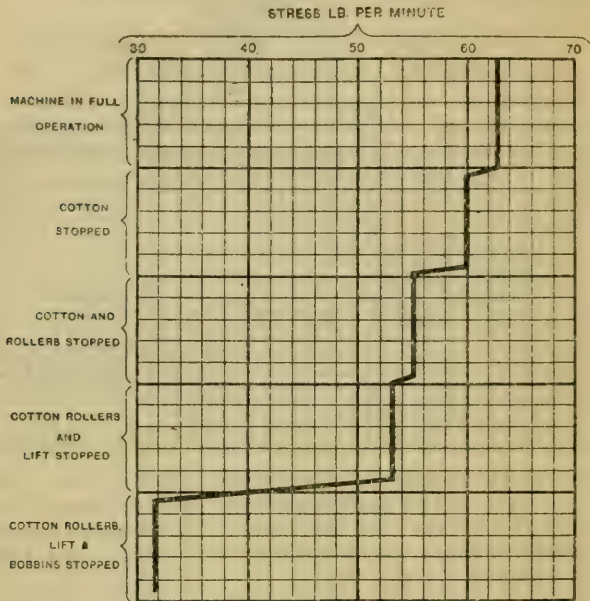
The next Diagram (page 150) shews the result of another test on the same machine, giving the power distributed to the various motions. The test was made when the bobbins were three-quarters formed, and the total H.P. delivered to the frame in full operation was 1.53. The frame contained 164 spindles. Speed of shaft, 400 revolutions; speed of spindles, 1,000 revolutions per minute. Roving, 5 hank, with 2.35 turns per inch.

Or in the following percentages :—

The machine in full motion takes 1.53 I.H.P. or	100	per cent.
Drafting the cotton requires 0.072 I.H.P. or	4.70	,,
Revolving the drafting rollers takes 0.120 I.H.P. or	7.84	,,
The lift takes 0.036 I.H.P. or	2.36	,,
The bobbins take 0.522 I.H.P. or ...	34.12	,,
The spindles (with frame shaft friction) 0.780 I.H.P. or	51.98	,,

Note.—It is a common occurrence to find frames absorbing as much as .014 H.P. per spindle, and even higher, especially where the floors are inferior asphalte and no precautions have been taken to prevent the machine from sinking. As the weight of a rover complete, includ-

ing weights and full bobbins, is from 60 lb. to 70 lb. per spindle, this, in conjunction with vibration, confirms the necessity for a firm foundation.



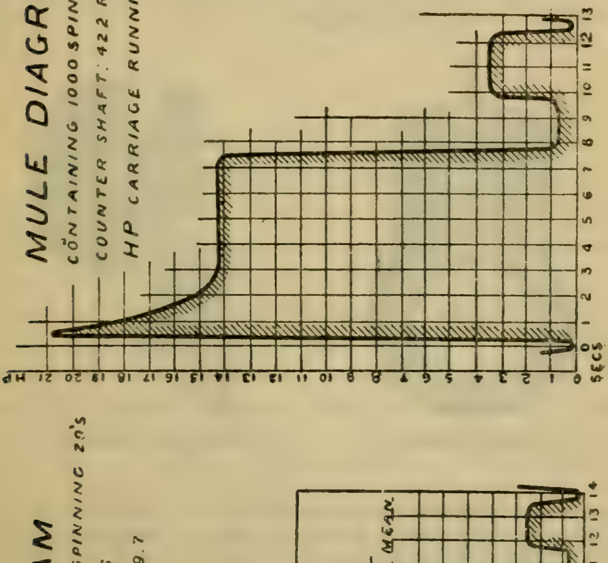
Power for Driving Self-acting Mules.

The Diagrams on the next page are records of power consumed in driving two self-acting mules, containing 780 and 1,000 spindles respectively, constructed by different makers.

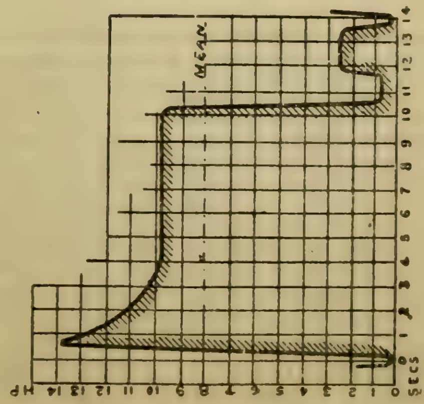
The Diagrams show there are three distinct actions, absorbing different degrees of power, namely—(1) The outward run of the carriage, during which the spinning takes place and the spindles run at their greatest speed. (2) The pause or rest at the finish of the "stretch," or the period when the backing-off takes place. (3) The return of the carriage, when the winding-on of the spun yarn takes place. When the carriage is at the roller beam the machine is practically stopped, so that at the commencement of the outward run the power required to overcome the inertia is very great and very sudden: hence the rapid rise in the Diagram. Afterwards the

fall is gradual and then constant, until the sudden fall for the third position, which absorbs the least power to drive it.

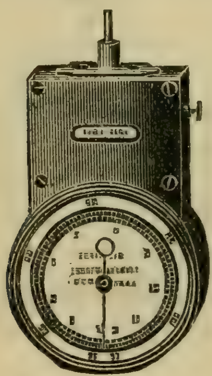
MULE DIAGRAM
CONTAINING 1000 SPINDLES; SPINNING 30's
COUNTER SHAFT: 422 REVS
HP CARRIAGE RUNNING OUT 14.26



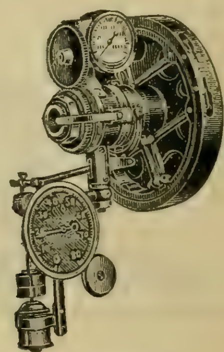
MULE DIAGRAM
CONTAINING 780 SPINDLES SPINNING 20's
COUNTER SHAFT: 529.4 REVS
HP CARRIAGE RUNNING OUT 9.7



Transmission Dynamometers.—These instruments are really power-weighing scales, inasmuch as the power transmitted through them is weighed after the manner of an ordinary "platform" weighing machine. The apparatus is generally attached to the projecting end of the machine driving-shaft. It is provided with two driving pins, which engage with the loose pulley of the machine, so that when the latter is turned by the strap or rope, the apparatus revolves with it. Accordingly, when the latter is secured to the shaft, and the strap or rope is on the loose pulley, the power driving the machine must be transmitted through the apparatus. By suitable lever mechanism the power thus exerted is



TACHOMETER.



DYNAMOMETER.

indicated in pounds on a graduated dial, which constitutes the dynamometer proper. After testing a machine in full motion, this apparatus can be used in ascertaining the power absorbed in any separate portion thereof.

Tachometers.—These are speed indicators, for showing at a glance (and without the assistance of a watch) the number of revolutions per minute made by a shaft spindle or other rotating object. The mechanism of the instrument is based on the principle that, when making a test, there is needed for high speeds only a slight pressure against the rotating object, while for slow speeds more pressure is required. The axis of the apparatus is carried internally in a slide, which is fitted with a spring that exerts an outward pressure. The instrument being applied lightly to the shaft, etc., under test, the axis remains in the first position, when the range

for highest speeds is in gear. When more pressure is applied, the slide carrying the axis recedes one step, whereupon other ratio wheels come into gear, thus connecting the second range. Still further pressure brings into operation the third range, and finally the fourth range for still smaller numbers of revolutions.

When desired, the axis can be locked at any one range by a half-turn of a bayonet-lock stud, fitted to the side of the wheel-case. The instrument is made in three sizes, with ranges varying from 3 to 5.

COMPARATIVE HORSE-POWERS.

1 Brake horse-power	=	1.1	Indicated horse-power.
1 ,, ,,	=	1.18	Electrical ,,
1 Indicated ,,	=	1.08	,, ,,

COTTON, YARN, AND CLOTH TESTING

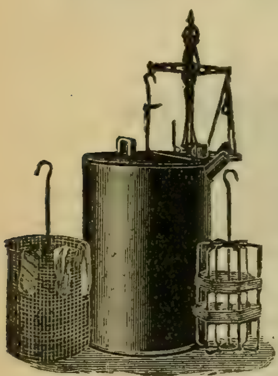
Moisture in Cotton.

All textile materials are hygroscopic: that is to say, they are capable of absorbing moisture from the atmosphere. Cotton contains 7 to 8 per cent. of water as a natural constituent; and if any or all of this be extracted, the cotton will, upon exposure to a suitable atmosphere, again absorb moisture up to the above normal percentage. Cotton may, however, easily contain twice the latter percentage without either altering in appearance or feeling unduly damp. With a material liable to such wide fluctuations—which may be due to the natural condition of the atmosphere, to the temperature of the spinning rooms, or to fraudulent practices—the necessity for a "standard" regarding moisture will be evident.

The standard now generally accepted is that known as a "regain" of certain percentages, which are given, for the various materials, on a later page. In the case of cotton the regain is 8½ per cent., meaning thereby that if 100 lb. of absolutely dry cotton—*i.e.*, cotton from which every particle of moisture, including the normal, has been extracted—if 100 lb. of such cotton were exposed to the atmosphere, it would absorb 8½ lb. of moisture. That is to say, cotton is considered to be in the "standard" condition when 108½ lb. contains 8½ lb. of moisture, this being equal to 7.83 per cent.

To ascertain the condition, a definite quantity of material is heated until absolute dryness is attained, the same being determined by frequent weighings and continuance of the heat until no further loss takes place. The addition of the percentage regain to the final weight then gives the weight in the correct condition. It is essential that the weighing be performed without removal of the material from the influence of the heat, otherwise reabsorption would immediately commence, and would interfere with the correctness of the result.

A reliable **Testing Oven** consists of two concentric cylinders, having an annular space in which heated air can freely circulate. The heat is obtained from a Bunsen ring burner fixed beneath the inner cylinder; outlet tubes ensure complete circulation of the heat and uniform drying of the material, and also removal of steam and moisture. A thermometer with bulb reaching half-way down the inner cylinder is provided to register the temperature within. Material in loose condition, or in the form of cops, is placed in the cage, and if in hanks is placed upon the reel, after which the whole is suspended within the cylinder from the scale end. The reel or cage exactly balances the weight end, so that weights in the latter represent net material.



Ovens of the above type are also made to be heated by electricity instead of by gas. In the former case two (sometimes three) electric heaters are employed. Each heater is controlled from a separate switch, so as to facilitate the regulation of the temperature. This system is less liable to fire, and as there are no fumes discharged it is less injurious to the person in charge. They also require less attention, as they can be constructed to regulate the temperature automatically to a predetermined maximum.

Other drying ovens again are heated either by means of a steam coil or steam-jacketed pan; and though perhaps their first cost is greater than that of other types, they are very convenient where steam is available, and they admit of the most accurate regulation of temperature.

TESTING RAW COTTON.

Considerable care must be exercised in collecting samples of cotton from bulk, in order to make the sample representative of the whole lot from which it is drawn. The sampling of a single bale is best carried out by cutting off all the hoops and drawing handfuls of cotton from five or six places well distributed over each of five or six separate layers throughout the whole bale. It is always the tendency of an inexperienced sampler to collect his samples from too near the centre of the bale and to neglect the outer edges. It should be borne in mind that a theoretically correct sample in this respect would be obtained by cutting from one layer a triangular piece of the layer, the apex of the triangle being at the centre of the layer and the base lying along one side or end. We do not suggest this being actually carried out in practice, but to do so would correctly demonstrate the large proportion of the outer part that should be taken to ensure "proportional representation." If a large number of bales are to be tested (say a hundred), then samples should be collected from at least five bales. Every bale tested should be weighed before sampling, and its weight brought into the calculation shewn under *Example I.* (below).

To make a test, samples making a total of $1\frac{1}{2}$ or 2 lb. are collected from different parts of the bulk, and placed as loosely as possible within the oven and then weighed. Next, the heat is turned on; and, 10 to 15 minutes after a temperature of 220 deg. to 230 deg. F. has been attained, weights are placed in the small pan attached to the cage wire, to restore equilibrium. The material is then shaken and turned top to bottom, and again submitted to the heat, and weighed at intervals of 5 to 8 minutes—until a constant weight, indicating absolute dryness, is obtained. The weights in the cage pan represent loss or moisture, and the same subtracted from the original weight (which has remained undisturbed throughout the operation) gives the dry weight. The addition of the percentage regain to the latter then gives the correct weight, or weight in the correct condition.

Excepting in the case of silk (which will stand up to 248 deg. F.), the above-named temperatures should not be exceeded—otherwise the material will be scorched.

Example I.—Suppose 2 lb. of cotton, taken from a 480 lb. bale, to lose 4 oz. in drying. The dry weight is

thus 1 lb. 12 oz., or 28 oz. Adding $8\frac{1}{2}$ per cent. of the latter (namely, 2.38), we obtain 30.38 oz. as the correct weight. Then, by proportion, if the correct weight of 2 lb. or 32 oz. be 30.38 oz., what is the correct weight of 480 lb.?

$$\frac{30{\cdot}38 \times 480}{32} = 455{\cdot}7 \text{ lb.}$$

Excess moisture = 480 − 455.7 = 24.3 lb.

Example II.—From a skip of cotton yarn weighing 260 lb. net, $1\frac{1}{2}$ lb. of cops is taken for testing. When absolutely dry, they weigh 1 lb. $5\frac{1}{4}$ oz. Can any claim be made for excess moisture? If so, to what amount, assuming the yarn to cost $10\frac{1}{2}$d. per lb.

Dry weight..........	21·25 oz.
Add $8\frac{1}{2}$ per cent .. =	1·80625
Correct weight ..	23·05625
Original weight......	24 oz
Correct weight	23·05625
Excess moisture ..	·94375

$$\text{Total excess moisture} = \frac{{\cdot}94375 \times 260}{1\frac{1}{2} \times 16} = 10{\cdot}22 \text{ lb.}$$

Amount of claim 10·22 lb. at $10\frac{1}{2}$d = 8s. $10\frac{1}{2}$d.

The pound and ounce avoirdupois weights are used in the above example. Gramme weights are, however, more convenient, both in use and in calculation.

Standard Regains.

The following is the list of "Standard Regains" together with the equivalent direct losses:—

Material	Regain.	Loss from normal condition.
Wool scoured	16 per cent.	13.79 per cent.
,, tops in oil..........	19 ,,	15.96 ,,
,, tops dry..............	$18\frac{1}{4}$,,	15.43 ,,
,, noils..................	14 ,,	12.28 ,,
,, yarns..................	$18\frac{1}{4}$,,	15.43 ,,
Silk	11 ,,	9.91 ,,
Cotton	$8\frac{1}{2}$,,	7.83 ,,
Flax	12 ,,	10.71 ,,
Jute	$13\frac{3}{4}$,,	12.09 ,,
Hemp	12 ,,	10.71 ,,

TESTING FOR COUNTS.

We find the terms "count" and "counts" applied indiscriminately to yarn as an indication of relative fineness or coarseness. From the point of view of cloth construction, it is useful to know how many threads may be made to lie parallel within a given space; and this necessitates not merely a relative knowledge of the diameter of yarns, but definite knowledge in terms of an inch or fraction of an inch. The following table, calculated from a very large number of tests made by Turner, Ashenhurst, and Barbour, will be found useful in this direction, and serve to emphasise the fact that some kind of relation exists between "counts" and diameter of yarn.

Diameters of Cotton Yarn,

Shewing the approximate number of threads lying side by side that occupy the space of one inch :—

Counts.	Theoretical Measurements assuming all yarn of same density.	Practical Measurements of yarn by Turner and others.
10	82	67
20	125	105
30	150	125
40	175	150
60	210	200
80	250	250
100	290	310
120	310	330

In plain weave cloth, each thread requires to have a space of 1¾ times its diameter to allow for intersection of warp and weft.

The table is generally used for the purpose of ascertaining the counts or threads per inch to be used in order to construct a new fabric correctly proportioned to an existing fabric.

Owing to the fact that some yarns are denser than others, and also to the difficulty of accurately measuring diameters of threads, the "**count**" of yarn cannot express any direct and simple weight or measurement: what it does express is *a relation of length to weight.* The units of length and weight that are involved are the hank (840 yards) and the pound (7,000 grains). Sometimes indeed the count of yarn is called the "**hank number,**" because it expresses the *number of hanks that go to make up one pound.*

It will be quite clear from the above that if we find the weight of a hank of yarn in grains and divide into 7,000, we shall at once ascertain the count of the yarn;

further, if we take for convenience one-seventh of a hank (called **a lea** = 120 yards), we shall only need to divide the weight in grains into 1,000 in order to ascertain the count.

Much labour has been wasted by the compilers of "Tables of Counts" in the endeavour to produce ready reckoners for reading off at a glance the count of a yarn of given weight per lea: for though these tables make great show of accuracy by stating three places of decimals, the simplest trial will shew that for some inscrutable reason they are inaccurate from beginning to end, one writer after another having copied the same mistake! Everyone knows (for example) that a lea of 50's yarn will weigh 20 grains exactly, but we find the tables give the weight as 20.011 grains. A further quite unnecessary complication is introduced by the use of ounces (ozs.) and pennyweights (dwts.)—whereas grain weights alone are simpler and are quite satisfactory.

Decimal Yarn Table.

The DECIMAL YARN TABLE that follows (pp. 160-163) is abstracted from a well-known table of reciprocals, and it is claimed not only to be free from error but to avoid the masses of useless figures in other tables, and that without sacrifice of accuracy. Indeed it is such that errors of interpolation cannot exceed one-half per cent. —as compared with one hundred per cent. in parts of the older tables.

To use the table, suppose we have three leas of yarn which weigh 206, 20.6, and 2.06 grains respectively. Opposite the figures 206 in the column headed "Grains" we find 485 in the Counts column. Then the counts of the first lea would be 4.85, of the second 48.5, and of the third 485. Similarly if a lea weighed 2,060 grains, its counts would be 0.485. The tables are also applicable to shorter lengths of yarn. Thus if 4.32 inches of 1/1,000th of a lea weighs 0.1105 grain the counts is 9.05. If 43.2 or 1/100th lea weigh 3.66 grains the counts is 2.73. Or if 12 yards weigh 8.8 grains, the counts is 11.36, and so on.

Table of Weights Used in Testing Cotton Yarns.

24 grains make 1 dwt.
$109\frac{3}{8}$ grains or 4 dwts. $13\frac{3}{8}$ grs. make $\frac{1}{4}$ oz.
$218\frac{3}{4}$ grains or 9 dwts. $2\frac{3}{4}$ grs. make $\frac{1}{2}$ oz.
$437\frac{1}{2}$ grains or 18 dwts. $5\frac{1}{2}$ grs. make 1 oz.
7,000 grains or 16 oz. make 1 lb.

The dwts. and grains are troy weight; the oz. and lb. avoirdupois weight.

Cotton Yarn Measure.

54 inches	=	1 thread (or circumference of wrap reel).						
4,320 „	=	80 „	=	1 lea.				
30,240 „	=	560 „	=	7 „	=	1 hank.		

1 Hank = 840 yards.

1 Bundle is usually 10 lb. in weight.

No. of yards ÷ 8.33 grains = Counts of Yarn.

French System of Numbering Yarns.

1,000 metres,	weighing	500	grammes	=	No. 1's.
1,000 „	„	250	„	=	„ 2's.
1,000 „	„	50	„	=	„ 10's.
1,000 „	„	25	„	=	„ 20's.

Rule—Number of metres reeled, *divided* by twice the weight of grammes.

To reduce English to French numbers, *divide* by 1.18.

Accuracy of Counts Tests.—Since weight and length alone are in question, is is clear that tests of count will be correct if the weighing and measuring of the yarn is correctly carried out, and, of course, *correct weighing* is little more than a matter of using suitable scales and weights. Where short lengths of fine yarn have to be tested (as, for example, in matching small samples of cloth), it is necessary to use a very accurate Balance, and weights suitable for weighing down to one-100th of a grain. Balances constructed on the quadrant principle or made from lightly suspended wires are unsuitable for this purpose, howsoever useful they may be in allowing the count of a given length of yarn to be read off without calculation. Very accurate balances, of the type used by analytical chemists, may now be obtained in glass cases for less than £2, and these are suitable for practically every kind of counts test made upon yarns. They are also used, of course, for ascertaining the weight of cloth per square inch, per square yard, or per piece; and it may be said that such a balance, howsoever unpretentious, is the most important instrument in any testing room.

Measuring Apparatus.—A Wrap Reel must be used for testing the counts of yarn when whole cops or hanks are available; and a good Yard Measure (made of brass and graduated to sixteenths) is all that is necessary for length testing when ascertaining count.

GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts
300	333	350	286	400	250	500	2000	600	1667	700	1429	800	1250
301	332	351	285	402	249	502	1992	602	1661	702	1425	804	1244
302	331	352	284	404	248	504	1984	604	1656	704	1420	808	1238
303	330	353	283	406	246	506	1976	606	1650	706	1416	812	1232
304	329	354	282	408	245	508	1969	608	1645	708	1412	816	1225
305	328	355	282	410	244	510	1961	610	1639	710	1408	820	1220
306	327	356	281	412	243	512	1953	612	1634	712	1404	824	1214
307	326	357	280	414	242	514	1946	614	1629	714	1401	828	1208
308	325	358	279	416	240	516	1938	616	1623	716	1397	832	1202
309	324	359	279	418	239	518	1931	618	1618	718	1393	836	1196
310	323	360	278	420	238	520	1923	620	1613	720	1389	840	1190
311	322	361	277	422	237	522	1916	622	1608	722	1385	844	1185
312	321	362	276	424	236	524	1908	624	1603	724	1381	848	1179
313	319	363	275	426	235	526	1901	626	1597	726	1377	852	1174
314	318	364	275	428	234	528	1894	628	1592	728	1374	856	1168
315	317	365	274	430	233	530	1887	630	1587	730	1370	860	1163
316	316	366	273	432	231	532	1880	632	1582	732	1366	864	1157
317	315	367	272	434	230	534	1873	634	1577	734	1362	868	1152
318	314	368	272	436	229	536	1866	636	1572	736	1359	872	1147
319	313	369	271	438	228	538	1859	638	1567	738	1355	876	1142
320	312	370	270	440	227	540	1852	640	1562	740	1351	880	1136
321	312	371	270	442	226	542	1845	642	1558	742	1348	884	1131
322	311	372	269	444	225	544	1838	644	1553	744	1344	888	1126
323	310	373	268	446	224	546	1832	646	1548	746	1340	892	1121

324	309	374	267	448	223	548	1825	648	1543	748	1337	896	1116
325	308	375	267	450	222	550	1818	650	1538	750	1333	900	1111
326	307	376	266	452	221	552	1812	652	1534	752	1330	904	1106
327	306	377	265	454	220	554	1805	654	1529	754	1326	908	1101
328	305	378	265	456	219	556	1799	656	1524	756	1323	912	1096
329	304	379	264	458	218	558	1792	658	1520	758	1319	916	1092
330	303	380	263	460	217	560	1786	660	1515	760	1316	920	1087
331	302	381	262	462	216	562	1779	662	1511	762	1312	924	1082
332	301	382	262	464	216	564	1773	664	1506	764	1309	928	1078
333	300	383	261	466	215	566	1767	666	1502	766	1305	932	1073
334	299	384	260	468	214	568	1761	668	1497	768	1302	936	1068
335	299	385	260	470	213	570	1754	670	1493	770	1299	940	1064
336	298	386	259	472	212	572	1748	672	1488	772	1295	944	1059
337	297	387	258	474	211	574	1742	674	1484	774	1292	948	1055
338	296	388	258	476	210	576	1736	676	1479	776	1289	952	1050
339	295	389	257	478	209	578	1730	678	1475	778	1285	956	1046
340	294	390	256	480	208	580	1724	680	1471	780	1282	960	1042
341	293	391	256	482	207	582	1718	682	1466	782	1279	964	1037
342	292	392	255	484	207	584	1712	684	1462	784	1276	968	1033
343	292	393	254	486	206	586	1706	686	1458	786	1272	972	1029
344	291	394	254	488	205	588	1701	688	1453	788	1269	976	1025
345	290	395	253	490	204	590	1695	690	1449	790	1266	980	1020
346	289	396	253	492	203	592	1689	692	1445	792	1263	984	1016
347	288	397	252	494	202	594	1684	694	1441	794	1259	988	1012
348	287	398	251	496	202	596	1678	696	1437	796	1256	992	1008
349	287	399	251	498	201	598	1672	698	1433	798	1253	996	1004

GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts	GRAINS	Counts
1000	100	1250	800	1500	667	1750	571	200	500	250	400
1005	995	1255	797	1505	664	1755	570	201	498	251	398
1010	990	1260	794	1510	662	1760	568	202	495	252	397
1015	985	1265	791	1515	660	1765	567	203	493	253	395
1020	980	1270	787	1520	658	1770	565	204	490	254	394
1025	976	1275	784	1525	656	1775	563	205	488	255	392
1030	971	1280	781	1530	654	1780	562	206	485	256	391
1035	966	1285	778	1535	651	1785	560	207	483	257	389
1040	962	1290	775	1540	649	1790	559	208	481	258	388
1045	957	1295	772	1545	647	1795	557	209	478	259	386
1050	952	1300	769	1550	645	1800	556	210	476	260	385
1055	948	1305	766	1555	643	1805	554	211	474	261	383
1060	943	1310	763	1560	641	1810	552	212	472	262	382
1065	939	1315	760	1565	639	1815	551	213	469	263	380
1070	935	1320	758	1570	637	1820	549	214	467	264	379
1075	930	1325	755	1575	635	1825	548	215	465	265	377
1080	926	1330	752	1580	633	1830	546	216	463	266	376
1085	922	1335	749	1585	631	1835	545	217	461	267	375
1090	917	1340	746	1590	629	1840	543	218	459	268	373
1095	913	1345	743	1595	627	1845	542	219	457	269	372
1100	909	1350	741	1600	625	1850	541	220	455	270	370
1105	905	1355	738	1605	623	1855	539	221	452	271	369
1110	901	1360	735	1610	621	1860	538	222	450	272	368
1115	897	1365	733	1615	619	1865	536	223	448	273	366

1120	893	1370	730	1620	617	1870	535	224	446	274	365
1125	889	1375	727	1625	615	1875	533	225	444	275	364
1130	885	1380	725	1630	613	1880	532	226	442	276	362
1135	881	1385	722	1635	612	1885	531	227	441	277	361
1140	877	1390	719	1640	610	1890	529	228	439	278	360
1145	873	1395	717	1645	608	1895	528	229	437	279	358
1150	870	1400	714	1650	606	1900	526	230	435	280	357
1155	866	1405	712	1655	604	1905	525	231	433	281	356
1160	862	1410	709	1660	602	1910	524	232	431	282	355
1165	858	1415	707	1665	601	1915	522	233	429	283	353
1170	855	1420	704	1670	599	1920	521	234	427	284	352
1175	851	1425	702	1675	597	1925	519	235	426	285	351
1180	847	1430	699	1680	595	1930	518	236	424	286	350
1185	844	1435	697	1685	593	1935	517	237	422	287	348
1190	840	1440	694	1690	592	1940	515	238	420	288	347
1195	837	1445	692	1695	590	1945	514	239	418	289	346
1200	833	1450	690	1700	588	1950	513	240	417	290	345
1205	830	1455	687	1705	587	1955	512	241	415	291	344
1210	826	1460	685	1710	585	1960	510	242	413	292	342
1215	823	1465	683	1715	583	1965	509	243	412	293	341
1220	820	1470	680	1720	581	1970	508	244	410	294	340
1225	816	1475	678	1725	580	1975	506	245	408	295	339
1230	813	1480	676	1730	578	1980	505	246	407	296	338
1235	810	1485	673	1735	576	1985	504	247	405	297	337
1240	806	1490	671	1740	575	1990	503	248	403	298	336
1245	803	1495	669	1745	573	1995	501	249	402	299	334

UNIVERSAL TABLE FOR NUMBERING COTTON, LINEN, AND WORSTED YARN.

No.	Grains	No.	Grains	No.	Grains	No.	Grains	No.	Grains	No.	Grains
5	1400.	24	291.8	43	162.8	62	112.9	81	86.4	100	70.
6	1166.6	25	280.	44	159.2	63	111.1	82	85.4	105	66.7
7	1000.	26	269.3	45	155.6	64	109.3	83	84.3	110	63.6
8	875.	27	259.3	46	152.2	65	107.7	84	83.3	115	60.9
9	777.8	28	250.	47	148.9	66	106.1	85	82.4	120	58.3
10	700.	29	241.5	48	145.8	67	104.4	86	81.4	125	56.
11	636.4	30	233.4	49	142.8	68	102.9	87	80.4	130	53.8
12	583.3	31	225.8	50	140.	69	101.4	88	79.5	135	51.8
13	538.5	32	218.8	51	137.3	70	100.	89	78.6	140	50.
14	500.	33	212.2	52	134.7	71	98.6	90	77.8	145	48.3
15	466.8	34	206.	53	132.1	72	97.2	91	76.9	150	46.7
16	437.5	35	200.	54	129.7	73	59.9	92	76.1	155	45.2
17	411.9	36	194.6	55	127.3	74	94.6	93	75.3	160	43.8
18	389.	37	189.3	56	125.	75	93.3	94	74.5	165	42.4
19	368.5	38	184.3	57	122.8	76	92.1	95	73.7	170	41.2
20	350.	39	179.6	58	120.7	77	90.9	96	72.9	175	40.
21	333.3	40	175.	59	118.6	78	89.7	97	72.3	180	38.9
22	318.3	41	170.8	60	116.7	79	88.6	98	71.4	190	36.8
23	304.5	42	166.7	61	114.8	80	87.5	99	70.7	200	35.

To Number Cotton Yarn.—Reel 840 yards = one hank. Weigh this, and against its weight of grains in the table will be found its number or count.

To Number Linen Yarn.—Reel 300 yards = one lea. Weigh it, and against its weight of grains in the table will be found its number or count.

To Number Worsted Yarn.—Reel 560 yards = one hank. Weigh it, and against its weight of grains in the table will be found its number or count.

Methods of Weighing and Measuring.

For rough testing there is little need to describe the methods of weighing and measuring; but accurate ascertainment of **weight** is a matter that requires a little practice. It must be kept in mind that the exact weight of any given object is not obtained until the swinging pointer of the balance vibrates to an equal number of degrees on each side of the midmost point of the scale. If the pointer remains stationary at that point, it by no means indicates that the weighing is accurate.

To obtain accurate measurement of **length** constitutes the greatest difficulty in testing for counts of yarn from a given sample, because all yarn is more or less elastic. A further difficulty lies in the fact that no standard of elasticity exists; and if it did exist it would be awkward to apply.

Considering first the measurement of yarn on a Wrap Reel, where it is customary to measure off one or more "leas" (120 yards) of yarn: we shall obtain quite different results, according to whether we take our sample of yarn from the end of a cop (in which case the yarn runs off freely and sets up very little tension) or whether the yarn is taken from a hank suspended upon a "swift" or a "barrel hank stand." It is practicably impossible to measure the yarn on to the Wrap Reel without an appreciable amount of tension when taken from the hank. Evidently, then, we might have the same count of yarn on cop and hank; but owing to the greater tension in reeling the latter it would stretch to a greater length, and the result would make the yarn appear finer than when tested from the cop.

As already pointed out, the difference might be of no consequence in a rough test; but in tests pretending to accuracy it is quite an appreciable one. In a particular instance the difference amounted to one count on 50's yarn. Until some recognised standard be adopted and agreed upon between buyers and sellers, neither test can be declared incorrect.

It has been suggested that to obtain a "standard" tension all yarn should be reeled from Schwartzenbach's "Reform Reel," using a brake on the reel spindle, this brake being loaded with certain weights suited to varying counts of yarn. A Wrap Reel has been so con-

structed that the tension of yarn may be either increased or diminished and brought to a standard; but it is an expensive instrument, and is therefore unlikely to come into extensive use.

The best advice that can be given to those using Wrap Reels is to measure their samples at a medium and uniform speed, to avoid undue tension when reeling from the hank, and to bear in mind that they are dealing with an elastic material which should receive carefully reasoned consideration.

Variation of Results.—Above and beyond all questions of accuracy in testing, lies the fact that yarn is liable to very great variation from one delivery to another, from skip to skip, from hank to hank, and from yard to yard. In the writer's experience over 90 per cent. of the complaints about incorrect tests of yarn are not due to faults in testing, but are due to this natural variation of count from place to place in the same or different cops, hanks, or deliveries. To guard against this uncertain factor, it becomes necessary to ensure first of all that the sample is taken from many parts of the lot or delivery it is supposed to represent; and then that as much of the sample is tested as circumstances permit. The point is one that applies to testing of every kind. It is worthy of far more attention than can possibly be given to it here, for it causes more misunderstanding and raises more practical difficulties than all other testing operations combined.

Testing Counts of Yarn Dissected from Cloth.

It will have been gathered from the foregoing remarks that our object should be to take as much yarn as possible out of the sample under dissection, to measure it carefully, and to weigh it accurately.

Testing Weft.—In testing weft, care should be taken to collect the yarn from several different places in the sample, these places being widely separated in the length of the piece of cloth under test, rather than to unweave one continuous length. The reason for this procedure is, of course, to avoid getting all our yarn from one original weft cop. In the warp we shall ensure a good average, even if we take only (say) 20 or 30 threads, for each of these will have come from different cops or bobbins; but it is, of course, all the better to take 100 or more threads to secure the best average. We may take any convenient length of cloth, both warp and weft way

(but preferably 30 inches if the size of sample permits), each thread being of the same length.

For example, in testing weft we may cut or tear the cloth parallel to the selvedge (and half an inch away from it), the cut or tear extending (say) half the length of the sample. We now roughly measure off 30 inches of weft from the aforesaid cut edge, making a second cut or tear through the weft threads, and taking care to follow the direction of the warp so that each weft thread shall be of the same length. Two or three successive weft threads are now withdrawn and carefully measured.

This measurement is perhaps the most important and difficult part of the test, for it is only by careful study of the operations of weaving, bleaching, and finishing that we can fully attain the object in view—which is, to draw out the thread to the length it originally occupied in weaving. It must suffice here to say that the thread should be stretched out until all the "kinks" or waves produced by weaving or finishing are straightened out.

This thread may now measure 31 or 32 inches, and we may either take a note of the exact length, or may once more cut down the cloth until the stretched length is exactly 30 or other "round number" of inches. Now proceed to pull out the weft threads, making them up into little bunches of 10, 20, or 30. When withdrawal of threads becomes difficult, the frayed edge of cloth may be cut away with scissors and the operation repeated; or, if the sample is large enough, strips of cloth may be torn away to present a fresh edge for dissection.

The measured and counted threads are now weighed in grains and decimal parts of a grain, and the calculation is made according to the following *Rule*:—

$$\frac{\text{yards} \times 100}{\text{grains} \times 12} = \text{counts.}$$

For example:—60 threads of 30 inches each = 12.2 grains

$$60 \times 30 = 1{,}800 \text{ inches.}$$
$$1{,}800 \div 36 = 50 \text{ yards.}$$

12.2 grains $\times$ 12 = 146.4, which divided into 5,000 (50 $\times$ 100) = 34.1. This last figure is the count of the yarn in question.

Testing of Warp.—The procedure for the testing of warps is carried out in similar manner. It is, of course, necessary to remove any size—either by thoroughly boil-

ing out the whole sample of cloth, or boiling the warp threads, and in either case drying and exposing to the air for a sufficient time to ensure something approaching to the normal content of moisture. (For very exact tests elaborate precautions have to be taken to ensure correct moisture content.)

The removal of size is frequently a somewhat difficult matter, owing to the nature of sizing materials; and acids, alkalis, volatile solvents, and diastase are all required for one or other of the size mixings or finishes that are to be met with. If the sample has been boiled for any great length of time, some of the natural wax of the cotton is dissolved away; and since we generally require to know the count of the original grey yarn, it may be necessary after such boiling to add as much as 2 per cent. to the weight of the tested yarn to compensate for this loss.

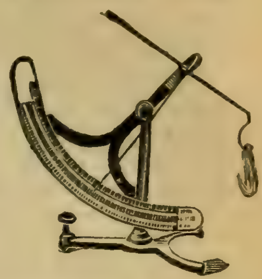
If the test has been carried out upon **bleached material**, and it is desired to state the count of the grey yarn, an addition of 7½ per cent. should be made to the weight of bleached yarn. This figure is a fair approximation to the actual loss in bleaching, though actual losses from this cause alone may vary from 5 to 10 per cent., or perhaps even more than that in exceptional cases.

In testing **hard-twisted yarns** taken from cloth, there is sometimes a natural inclination to grasp one end of the yarn and to pull it away in such a manner that a good deal of the twist comes out, and consequently the length is greater than it should be. The error is, of course, easily avoided by taking out the threads to be measured from the extreme edge of the cut sample, and by grasping both ends of the sample, thus preventing the twist from running out.

Dyed yarns of light shade that have been bleached do not as a rule gain much weight in dyeing, and we may use the same correction as for bleached yarns. **Mercerised** yarns or cloth may have an addition of 10 per cent. made to their weight to compensate for loss. All results are supposed to represent the count of the GREY yarn; and if the necessary allowances are not made, the fact should be stated when entering results.

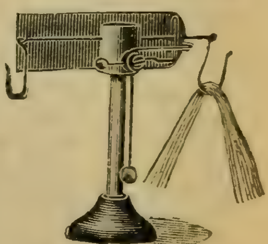
Short lengths of yarn are conveniently tested by the **Quadrant.** The arc has three scales engraved upon its face, the lower of which is used to indicate the counts of four yards, and the middle scale when 40 yards are tested. The first length is obtained by cutting 40

threads to a templet of one-tenth yard, and the second by wrapping a thread 40 times round a half-yard templet. When either length is hung upon the hook, the pointer indicates the count upon the corresponding scale. The top scale gives the weight of 100 yards of cloth 36 inches wide, when a piece one-tenth yard square (cut by the aid of the smaller templet) is hung upon the hook.



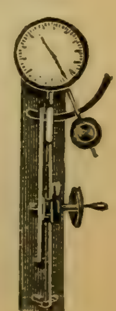
The smaller templet is chiefly used to test the counts of yarn from cloth. In this respect it is advisable to remember that the waviness due to interweaving should be removed by stretching the threads before they are cut; and also that any size or filling should be cleared away by boiling, otherwise the true count cannot be obtained. When bleached or dyed yarns are tested, allowance must be made for the influence of these processes upon the weight and counts of the yarn.

The "Thomas" balance is also used for testing the counts of yarn from cloth. Threads are cut to templets provided, and the number of these that balance the wire beam gives the count. The pendulum shown has its upper end bent at right angles and balanced by a counterpoise. Thus the upper end always assumes a horizontal position whatever be that the supporting pillar; and it is then an easy matter to determine when the wire beam is exactly balanced.



TESTING FOR STRENGTH AND ELASTICITY.

The machine in general use for this purpose is the Lea Tester. A lea of yarn from the wrap reel is placed upon the hooks, and the lower one is then caused to descend by turning the handle. Thereupon the upper hook pulls round a small drum, into which a weighted lever is bolted, thus causing the weight to travel outwards and pull against the yarn until the latter breaks, at which point the weight is supported by a curved rack. A sector on the drum moves a finger in front of the dial, on which is engraved a scale of lb., representing the dead-weight pull.



Elasticity or stretch is measured by means of two small scales of inches engraved upon the pillar opposite to the upper and lower hooks. Thus the distances travelled by the two hooks, during the making of a strength test, can be observed.

Suppose the upper hook to travel $1\frac{1}{4}$ inches while the lower one moves $2\frac{3}{4}$ inches, then the difference is $1\frac{1}{2}$ inches, or a total of 3 inches upon the length of the lea, the latter being doubled when on the hooks. The lea being 54 inches, the stretch is equal to—

$$\frac{3 \times 100}{54} = 5{\cdot}56 \text{ per cent.}$$

The Lea Test.—A deal of criticism has recently been directed against the Lea Test for Strength; nevertheless, it must not be overlooked that the test has some very definite advantages from the practical point of view. It is a test that can be made very readily at the same time the test is being made for counts, and it gives far more concordant results than do single-thread tests. Half-a-dozen lea tests for strength will yield quite a fair average, while fifty or a hundred tests of the single thread are required. The lea test is about as unscientific a test as could well be devised; but it possesses a positive advantage over the single thread test in giving what we might call disproportionate prominence to the existence of weak places in the yarn—for weak places give way first in this test, and not only do they then take no further part in maintaining the strength of the lea, but the yarn for half-a-yard or more on each side of the broken place fails to maintain the strength of the remainder.

The only test at all likely to replace the lea test is one that measures the amount of *work done* in breaking the yarn; for this test takes into account the elasticity as well as the dead-weight pull—and after all we never "test" our yarns in actual use under the slow and regular conditions of the existing testing machines. Yarn is broken in practice by the hammering of the reed or by the pluck of the shuttle, either strain being of a snapping or plucking nature; and that is the nature of the strain described by the term "work done," or (as it might be called) energy absorbed.

The Testing of Single Threads is referred to under "Testing for Regularity."

YARN STRENGTHS PER LEA.

The following table of Yarn Strengths is compiled from the testing of average yarns of the counts and qualities named. It should be remembered, however, in using the table, that wide differences in the strengths per lea may result from differences in the quality of cotton used, in the method of treatment, and in the degree of twist in the yarn.

YARN STRENGTHS IN LB. PER LEA.

Counts	Carded Americ'n Twist	Carded Egyptian Twist	Carded Egyptian Weft	Combed Egyptian Twist	Combed Egyptian Weft	Extra Combed Egyptian Twist	Extra Combed Egyptian Weft
20's	80	...	...	...	...	...	...
32's	52	...	...	...	...	...	...
36's	40	...	...	...	...	...	...
40's	36	55	...	...	...	...	...
46's	...	46	43	...	...	...	...
50's	...	42	40	44	...	...	...
60's	...	33	30	36	...	44	...
70's	..	28	23	32	...	35	...
80's	..	23	20	26	24	29	...
90's	...	.	18	22	21	24	23
100's	...	...	15	...	18	21	19
110's	...	...	...	...	13	...	17
120's	...	...	...	...	...	...	14
130's	...	...	...	...	...	..	12
140's	...	...	...	...	...	.	11
150's	...	...		...	...	...	10

TESTING FOR TWIST.

Testing for twist consists in untwisting a thread and noting the number of turns per inch given before complete parallelism of fibres or threads has been obtained. Single threads are not usually tested for twist, as a turn or two more or less does not materially affect the strength or appearance of the ordinary run of single yarns; and manufacturers do not concern themselves about the exact number of turns so long as there is sufficient strength for working purposes, and sufficient fulness to give a well covered fabric. But doubled yarns are invariably so tested, on account of the influence of the twist upon their appearance and suitability for the special purposes to which they are to be applied.

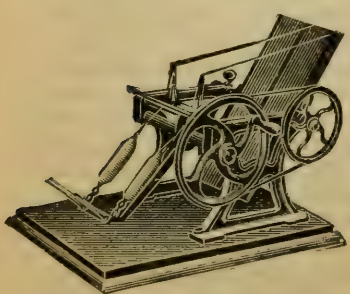
The figure shows an ordinary Twist Tester, in which the left-hand pillar is fixed and is provided with split

jaws capable of being tightly screwed together to grip the thread. The right-hand pillar is movable upon a brass scale engraved with inches, and is provided with a hand-wheel attached to or geared with a split spindle,

which receives the thread. When the movable pillar has been fixed at the desired distance and the thread secured in the jaws and spindle, the latter is revolved until the whole of the twist has been removed. The number of revolutions is indicated upon a dial; and this number divided by the number of inches tested, gives the number of turns per inch.

Hard-twist and **crepe yarns** must be tested for twist, and in case of singles a length of one inch between the jaws of the machine is taken at reasonable tension, the twist being taken out until the fibres are parallel at the left hand or fixed end of the sample. Examination under a low magnifying power, and a little deft handling with the tips of the finger and thumb, may be necessary to secure parallelism. When the fibres are in parallel order at the left-hand end, they are grasped and retained in that position while more of the fibres towards the right-hand end are brought into similar order, the twist being gradually worked out towards the right. The operation is a somewhat delicate one, and requires considerable practice. Anything less than the average of twenty tests is of little or no practical value.

Some machines have been made to take out the twist at both ends of the sample at the same time; but in the writer's experience they possess no advantage over the ordinary type, and for some purposes they are a serious hindrance to the carrying-out of the test.



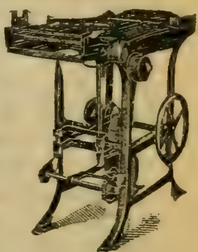
Regularity.

The Yarn Examining Machine is used to examine and compare the quality, evenness and freedom from defects of yarns. A stout sheet of black cardboard is held by revolving clips, driven by the hand-wheel. When the latter is turned, the thread is evenly wound at close intervals upon the card, but sufficiently apart to reveal any unevenness or faulty places, which quickly shew up

against the dead-black surface of the board. The cards are removable, and can thus be labelled and kept for reference.

The regularity of yarn may be tested by making a number of tests of count upon short lengths; but the method is of no use whatever as applied to a single sample, because all yarn is more or less irregular, and we must have two or more samples to compare together if we are to utilise this very practical and useful test. With this in mind, we shall, of course, always weigh our leas of yarn separately when testing for count, and not group them together (as the tester generally does) into lots of three or four.

If tests of yarn for count are made upon short lengths, say one-yard lengths, enormous differences will be found to exist in different parts of the same sample. This is a method of testing that should always be applied to a yarn that gives bad results in weaving while apparently giving satisfactory routine tests of count and strength. Of course, a comparison must be made with a satisfactory yarn of equal count.



Single thread testers are now available for determining the breaking strength of individual threads. In the machine illustrated opposite, the threads from six cops or bobbins are broken against the pull of springs, and once the machine has been set in motion it automatically tests successive lengths of 12 inches, and records the results in diagrammatic form until the whole contents of the cops or bobbins have been exhausted, without requiring further attention.

Strengths of Ring Yarn.

The following table gives the average of ten tests in each case of a standard ring yarn spun from American cotton :—

Weight of Lea in Grains	Counts	Strength in lb.
63.3	15.79	118
54.6	18.31	102.9
50.25	19.90	92.3
44.9	22.27	80·8
41.2	24.27	72.6
37.3	26.80	66.3
35.0	28.57	63.2
32.65	30.62	58.5

DEFECTIVE YARN: ITS CAUSES, EFFECTS, &c.

Dirty Yarn.—This occurs when the processes of opening and preparing the cotton have failed to remove all suspended impurities. These usually consist of fragments of leaves and seeds adhering to the fibres.

Stained Yarn.—May be caused by the working-up of stained cotton, but is chiefly due to carelessness of the mill operatives in allowing oil to come into contact with the yarn. Is also often caused by a broken thread not receiving immediate attention, and striking some part of the machine, thus picking up grease and dirt. This it conveys to its neighbour when pieced-up. Stained yarn may sometimes arise from operatives having dirty hands, or from impure water when the doubling is on the "wet" principle.

"Nepped" Yarn.—So named because it contains small pieces of hard cotton, called "neps." These vary in size from very small particles, to others the size of a pin-head. There are two kinds—commonly distinguished as "natural" neps and "mill" neps. The former consist of short and undeveloped fibres that have become embedded in the yarn. The latter ("mill" neps) are impurities and also short fibres usually found adhering to the surface of the threads.

'Slubs' or 'Ooze.'—These occur when the twist in the yarn is not uniform. They appear as thick places, which have received insufficient twist. They are caused by what is called "thick" or "jammed" roving: that is, two rovings overlapping each other (say an inch or more), which thus pass through the rollers without receiving the amount of twist required.

"**Snarls.**"—These are curls or loops in the yarn and are caused chiefly by bad winding in the mule. This may sometimes be traced to faulty spindle-blades, the tops of which interfere with the coiling of the yarn on the cop.

"Snicks."—Places where the yarn is almost cut through. They are attributable to the use of badly covered rollers, or to over-weighting. Sometimes they are due to the draft rollers being too wide in the settings for the length of staple spun, thus causing undue stretch in the yarn.

Corkscrew Yarn.—Occurs in doubled yarn when one of two or more folded threads is imperfectly twisted,

and—not clinging closely to its neighbour—coils loosely round in a "corkscrew" fashion: hence it derives its designation. The same fault may arise from imperfect tension on some of the threads.

TESTING THE STRENGTH OF CLOTH.

No department of testing has made greater progress during the last ten years than this. The advance is due mainly to the inclusion of strength tests, first of all in Government specifications, and more recently in the specifications of railway companies and other large users of textiles.

A convenient classification of testing machines may be made into those which hold the sample in a vertical position and those which hold it horizontally. The latter class possess a clear advantage in respect of the facility with which the sample may be adjusted to lie flat and square between the grips or jaws. The former class, on the other hand, generally lay claim to greater accuracy, owing to free suspension of the sample, or to the employment of "knife-edge" suspension of the main beam—this method of construction being inconvenient or impossible in the horizontal type. All machines grip one end of the sample between jaws, which can be gradually pulled away from jaws at the other end of the spindle, attached to some kind of weighing or balancing mechanism. The balancing may be achieved by the running of water or shot into a bucket, or by the rotation of a spindle to which a hanging weight is rigidly attached. None of these machines can strictly be called dead-weight machines, though many of them claim the title in distinction from the rapidly vanishing spring balance type.

In all these machines (with but one exception) one end of the sample is drawn away from the other at a specified speed, generally eighteen inches per minute; but since the opposite end moves at a speed which varies with the character of the cloth under test, it is by no means true that the sample under test is extended at constant speed, a very elastic cloth being extended far more slowly than one of hard or "brittle" texture. In the machine now favoured by the National Physical Laboratory, no attempt is made to cause extension at a constant rate; but the more rational method of adding the load constantly is adopted. In other words, the weight is gradually added to the sample at one end, and the other end of the sample is pulled out as may be required to take up the stretch. This latter method of

testing possesses all the advantages of testing all kinds of cloth under similar conditions; but by far the greatest number of machines in use to-day are of the horizontal quadrant type.

It need perhaps scarcely be pointed out that the conditions of testing are quite different if tests are made on machines with a range of 100 lb. and 1,000 lb. respectively, when those machines have jaws with the same standard rate of movement.

Many circumstances have combined to prevent the establishment of **standard dimensions** for the samples placed in the machines; but it has now become quite the usual practice to define (for example) a " 9 × 4 " test as a test in which the jaws are 9 inches apart and the strip of cloth is 4 inches wide—whereas in bygone days the sample was cut to the 9 in. × 4 in. dimensions before placing it in the machine, the distance between the jaws not being stated. In many cases it is necessary to cut the sample from ¼ inch to ½ inch wider than the required dimension, and then to strip away side-threads until the width is sufficiently reduced—for obviously a fair test can only be obtained if every individual thread is securely grasped at both ends in the machine. Care must also be taken to lay the sample as square and true in the jaws as possible; and if there is any tendency towards slipping out of the jaws, it may be necessary to pack the sample between slips of woollen cloth or rubber. The propulsion of the machine by power at a regular speed is, of course, an advantage, and becomes a necessity for official tests. The amount of stretch sustained by the sample may be ascertained from the pointer and sliding scale generally fitted; and for those who understand its use, a stress and strain diagram may be made by taking several simultaneous observations of load and elongation.

Attention must be called to the fact that the results of testing the strength of cloth disclose what has often been called an unaccountable variation, or the machine has been blamed as unreliable. Extended testing, however, will convince any thoughtful person that the variation actually exists in the cloth itself; consequently it becomes necessary to make a considerable number of tests before we are justified in accepting an average as being fairly representative. Finally, it should be borne in mind that the test as generally carried out is of a somewhat arbitrary nature, and that consequently two sets of tests should only be compared together when made under strictly the same conditions.

ACCESSORIES

For a Ring Mill of 50,000 Spindles.

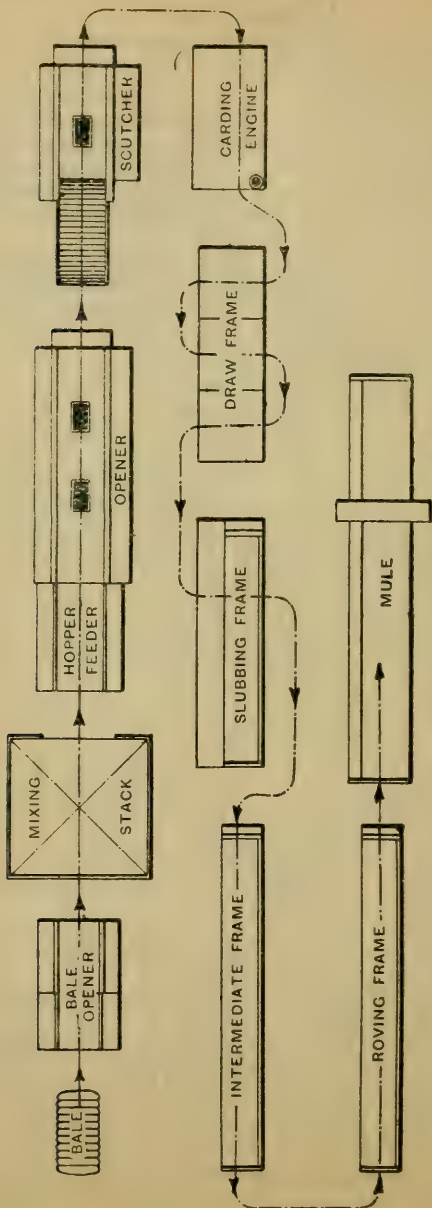
ROLLER COVERING PLANT :—

Cloth Covering Machine.
Leather Cutting Board.
Splicing Machine.
Piecing Press.
Pulling-on Apparatus.
Grinding or Equalising Machine.
Truing and Varnishing Machine.
Roller-ending Machine.
Calendering Machine.
Testing Apparatus.
250 yards Roller Cloth.
100 yards Clearer Cloth.
100 doz. Roller Skins.
8 gallons Roller Varnish, Roller Cement, and Glue.
1 Mounting and Stretching Machine for Clothing the Carding Engine Cylinders, along with Punch, Wire Puller, Pincers, Knife, and Tack Hammer.
112 gross Card-mounting Tacks.
1 Flat-grinding and Flat-testing Apparatus.
55 Complete sets of Card Clothing.
1 Set Grinding Roller Filleting.
2 Stripping and 5 Burnishing Rollers.
120 Lap Rods.
1 Pair Lap Scales.
70 gross Slubbing Tubes.
2,400 Sliver Cans.
135 gross Intermediate Tubes.
140 gross Skewers for above Tubes.
610 gross Skewers for Tubes.
960 gross Roving Tubes.
3.500 gross Ring Frame Bobbins.
30 lb. Opener Banding, ⅝ in. dia.
180 lb. Card Banding, ⅜ in. dia.
1,600 Ring Spindle Banding (tubular).
150 Boxes Travellers, ranging from 4's to 10's—from 4/o and upward. (The small-bore traveller is advisable; for sizes, etc., see pages 109-110.
1 Oil Pump for Spindles.
150 Bobbin Skips.
100 Long Brushes.
100 Card Brushes.
25 doz. Hand Brushes.
100 Small Wheel Brushes.
25 doz. Oil Cans.
2 Oil Cisterns, capacity 2 gallons.
1 Large Cistern, capacity 50 gallons of oil.
Belting according to height and design of mill and in widths from 1 to 6 inches.
4 Strap Punches.
1 Belt-splicing Machine.
Main Driving Rope 1¾ in. dia.; length, etc., according to design of mill.
1 Wrap Drum for Sliver.
1 Yarn Testing Machine.
1 Wrap Reel for Yarn.
2 complete sets of Screw Keys and an assortment of Fitters' Tools.

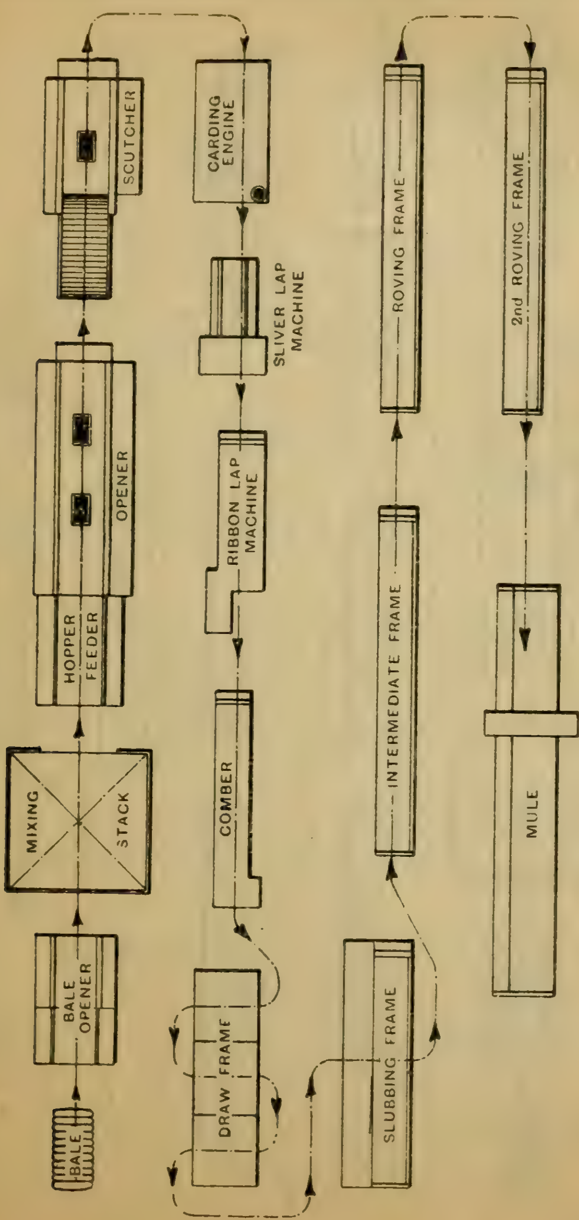
GRINDING MACHINERY FOR CARD WIRE :—

4 Traverse Wheel Grinders for Cylinders and Doffers.
5 Long Grinding Rollers for Flats.

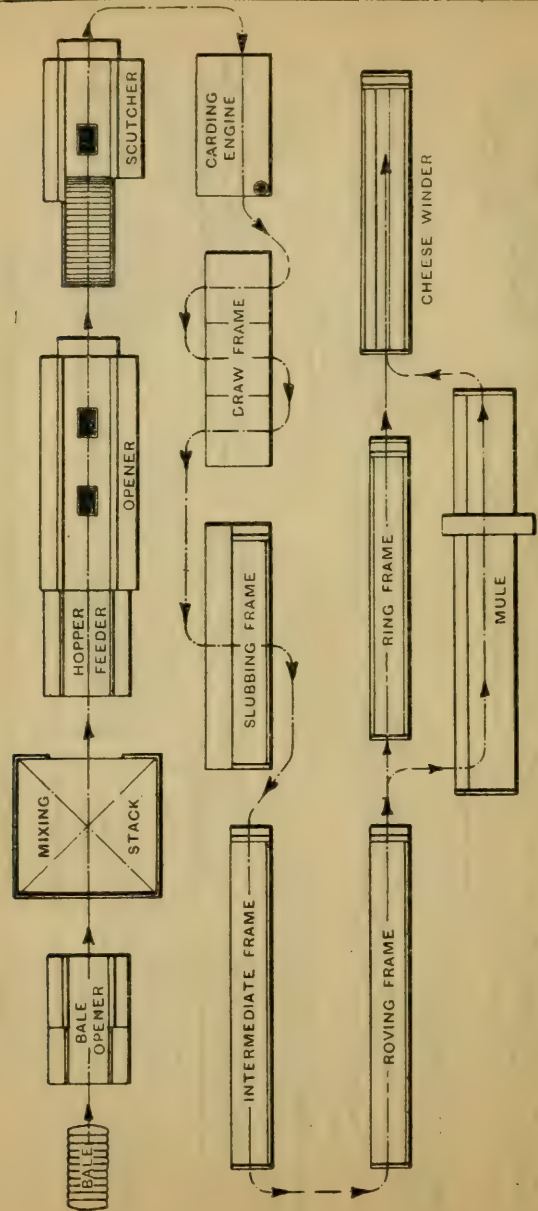
(For Plans showing Sequences of Machines and for other Preparations, see following pages.)



SEQUENCE OF MACHINES FOR PREPARING AND SPINNING COTTON INTO MULE YARN.



Sequence of Machines for Preparing and Spinning Cotton into Fine Counts.



Sequence of Machines for Ring and Mule Yarn for Sale in Cheeses.

HANK ROVINGS AND DRAFTS

For Other Preparations.

EGYPTIAN COTTON.

60's RING YARN (COMBED).

Scutcher lap 11 oz. per yard.

Card	150 draft		30 grs. per yd.	·277 hk. carded
Sliver lap M ...	17 ends up	2 draft	255 grs. per yd.	10½ dwt.
Ribbon „ ...	6 „	6 „	255 „	„
Comber	8 „	40 „	42 „	
1st head D.F.	8 „	8 „	42 „	
2nd „ ...	8 „	8·25 „	40 „	
3rd „ ...	8 „	8·5 „	37 „	·225 hk.
S.F.	1 „	6 „	125 grs. 30 yds.	1·35 hk.
I.F.	2 „	6·3 „	117 „ 60 „	4·25 hk.
R.F.	2 „	6·6 „	70·3 „ 120 „	14
Ring Sp. F.	2 „	8·6 „	60's	

60's MULE YARN (CARDED).

Scutcher lap 12 oz. per yard.

Card	137 draft		36·4 grs. per yd.	
1st head D.F. ...	8 ends up	8 draft	36·4 „	
2nd „ ...	8 „	8·25 „	35·3 „	
3rd „ ...	8 „	8·5 „	33·3 „	= ·25 hk.
S.F.	1 „	5 „	198 grs. per 30 yds.	1·25 „
I.F.	2 „	6 „	130 „ 60 „	3·75 „
R.F.	2 „	6·4 „	82 „ 120 „	12 „
Mule	2 „	10 „		

80's WEFT MULE YARN (CARDED).

Scutcher lap 12 oz.

Card		137 draft	36·4 grs. per yd.	
1st head D.F. ...	8 ends up	8 „	36·4 „	
2nd „ ...	8 „	8·25 „	35·3 „	
3rd „ ...	8 „	8·5 „	33·3 „	·25 hk.
S.F.	1 „	6 „	165 grs. per 30 yds.	1½ „
I.F.	2 „	6 „	108 „ 60 „	4½ „
R.F.	2 „	6·4 „	67·2 „ 120 „	14½ „
Mule	2 „	11 „		80's „

80's TWIST MULE YARN (COMBED).

Scutcher lap 11 oz. per yard.

Card		150 draft	30 grs. per yd.	
Sliver lap M	17 ends up	2 „	255 „	10½ dwt. lap
Ribbon „	6 „	6 „	255 „	
Comber, 18% waste	8 „	40 „	42 „	
1st head D.F.	8 „	8 „	42 „	
2nd „	8 „	8·25 „	40 „	
3rd „	8 „	8·5 „	37 „	= ·225 hk.
S.F.	1 „	6 „	185 grs. per 30 yds.	= 1·35 „
I.F.	2 „	6·3 „	117 „ 60 „	= 4·25 „
R.F.	2 „	6·6 „	70·8 „ 120 „	=14 „
Mule	2 ,	11·4 „	80's	

100's MULE YARN (COMBED).

Scutcher lap 11 oz. per yard.

Card		150 draft	30 grs. per yd.	·277
Sliver lap M ...	17 ends up	2 „	255 „	10½ dwt.
Ribbon „ ...	6 „	6 „	255 „	
Comber, 18% waste	8 „	40 „	42 „	
1st head D.F. ...	8 „	8·3 „	40 „	
2nd „ ...	8 „	8·6 „	37 „	
3rd „ ...	8 „	8·8 „	33·6 „	·24 hk.
S.F.	1 „	6 „	165 grs. per 30 yds.	1·44 „
I.F.	2 „	6·5 „	103 „ 60 „	4·7 „
R.F.	2 „	7 „	58·8 „ 120 „	16·6 „
Mule	2 „	12 „		

120's MULE YARN (COMBED).

Scutcher lap 11 oz. per yard.

Card		150 draft	Sliver 30 grs. per yd.	·277
Sliver lap M....	17 ends up	2 „	255 grs. per yd.	
Ribbon „ ...	6 „	6 „	255 „	
Comber „ ...	8 „	40 „	42 „	
1st head D.F....	8 „	8 „	42 „	
2nd „ ...	8 „	8·25 „	40 „	
3rd „ ...	8 „	8·5 „	37 „	·225 hk.
S.F.	1 „	4·44 „	249 grs. per 30 yds.	1 „
I.F.	2 „	5 „	250 „ 60 „	2½ „
R.F.	2 „	5·2 „	153 „ 120 „	6½ „
F.J.F.	2 „	6·14 „	50 „ 120 „	20 „
Mule...............	2 „	12 „		

160's MULE YARN (COMBED).

Soutcher lap 11 oz. per yard.

Card		150 draft	Sliver 30 grs. per yd.	
Sliver lap M....	17 ends up	2 ,,	255 grs. per yd.	
Ribbon ,, ...	6 ,,	6 ,,	255 ,,	
Comber	8 ,,	40 ,,	42 ,,	
1st head D.F....	8 ,,	8 ,,	42 ,,	
2nd ,, ...	8 ,,	8·25 ,,	40 ,,	
3rd ,, ...	8 ,,	8·5 ,,	37 ,,	·225 hk
S.F.	1 ,,	4·44 ,,	249 grs. per 30 yds.	1 ,,
I.F.	2 ,,	5·5 ,,	182 ,, 60 ,,	2¾ ,,
R.F.	2 ,,	5·8 ,,	125 ,, 120 ,,	8 ,,
F.J.F.	2 ,,	6·5 ,,	38 ,, 120 ,,	26 ,,
Mule..............	2 ,,	12·2 ,,		

150's MULE YARN (DOUBLE COMBED).

Card 20 grs. sliver per yd.
1st Drawing head, 6 ends up. 6 draft.
1st Lap machine, 14 ends up, 1·3 draft = lap 7 dwt. 12 grs. per yd.
1st Comber, 20% waste; sliver produced, 19 grs. per yd.
2nd Lap machine, 14 ends up, draft 1·1 = lap 8 dwt. per yd.
2nd Comber, 4% waste = sliver 26 grs. per yd.
1st Drawing head 6 ends up 5 draft sliver 10 yds. = 310 grs. = 31 grs. per yd.
2nd ,, 6 ,, 5 ,, 34½ ,,
3rd ,, 6 ,, 6 ,, 34 ,,
S.F. 4·4 draft 30 yds. = 9 dwt. 11 grs. = 1·1 hk.
I.F. 5 ,, 30 ,, = 92 grs. = 2·77 hk.
R.F. 6 ,, 60 ,, = 60 grs. = 8.3 ,,
F.J.F. 6·3 ,, 120 ,, = 38 grs. = 26 ,,
Mule 11·5 ,, = 150's.

AMERICAN COTTON.

20's RING YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	1	110	60 grs. ,,
D.F. 1st head	6	6	60 grs. ,,
,, 2nd ,, ...	6	6·125	58·7 grs. ,,
,, 3rd ,, ...	6	6·2	56·8 grs ,, = ·146 h.r.
S.F.	1	3·42	·5 hank roving.
I.F......................	2	4·5	1·125 ,,
R.F.	2	5·5	3·125 ,,
Ring	1	6·4	20's.

30's RING YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	1	110	60 grs. ,,
D.F. 1st head	6	6	60 grs. ,,
,, 2nd ,, ...	6	6·125	58·7 grs. ,,
,, 3rd ,, ...	6	6·2	56·8 grs. ,, = ·146 h.r.
S.F.	1	4·2	·625 hank roving.
I.F.	2	4·75	1·48 ,,
R.F.	2	5·74	4·25 ,,
Rings	1	7	30's.

40's RING YARN.

Finishing Scutcher	4	—	16 oz. per yard.
Card	1	115	56 grs. ,,
D.F. 1st head	6	6	56 grs. ,,
,, 2nd ,, ...	6	6·125	54·8 grs ,,
,, 3rd ,, ...	6	6·25	52·6 grs. ,, = ·158 h.r.
S.F.	1	4·43	·7 hank roving.
I.F.	2	5·3	1·875 ,,
R.F.	2	5·8	5·5 ,,
Rings	1	7·3	40's.

50's RING YARN.

Finishing Scutcher	4	—	16 oz per yard.
Card	1	132	50 grs. ,,
D.F. 1st head	6	6	50 grs. ,,
,, 2nd ,, ...	6	6·25	48 grs. ,,
,, 3rd ,, ...	6	6·5	44·3 grs. ,, = ·188 h.r.
S.F.	1	4·2	·8 hank roving.
I.F.	2	5·3	2·125 ,,
R.F.	2	6·1	6·5 ,,
Ring	1	7·6	50's.

20's MULE YARN.

Finishing Scutcher	4	—	16 oz. per yard.
Card	1	110	60 grs. ,,
D.F. 1st head	6	6	60 grs. ,,
,, 2nd ,, ...	6	6·125	58·7 grs. ,,
,, 3rd ,, ...	6	6·2	56·8 grs. ,, = ·146 h.r.
S.F.	1	3·42	·5 hank roving.
I.F.	2	4·5	1·125 ,,
R.F.	2	5·3	3 ,,
Mule	1	6·6	20's.

30's MULE YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	110	—	60 grs. ,,
D.F. 1st head	6	6	60 grs. ,,
,, 2nd ,, ...	6	6·125	58·7 grs. ,,
,, 3rd ,, ...	6	6·2	56·8 grs. ,, = ·146 h.r.
S.F	1	4·1	·6 hank roving.
I.F......................	2	4·66	1·4 ,,
R.F.	2	5·35	3·75 ,,
Mule	1	8	30's.

40's MULE YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	1	115	56 grs. ,,
D.F. 1st head	6	6	56 grs. ,,
,, 2nd ,, ...	6	6·125	54·8 grs. ,,
,, 3rd ,, ...	6	6·25	52·6 grs. ,, = ·158 h.r.
S.F.	1	4·1	·65 hank roving.
I.F......................	2	5·38	1·75 ,,
R.F.	2	5·57	4·875 ,,
Mule	1	8·2	40's.

50's MULE YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	1	115	56 grs. ,,
D.F. 1st head	6	6	56 grs. ,,
,, 2nd ,, ...	6	6·125	54·8 grs. ,,
,, 3rd ,, ...	6	6·25	52·6 grs. ,, = ·158 h r.
S.F.	1	4·1	·65 hank roving.
I F......................	2	5·38	1·75 ,,
R.F.	2	5·85	5·125 ,,
Mule	1	9·75	50's.

60's MULE YARN.

Machine.	Ends up.	Draft.	Weight of sliver or hank roving.
Finishing Scutcher	4	—	16 oz. per yard.
Card	1	115	56 grs. ,,
D.F. 1st head	6	6	56 grs. ,,
,, 2nd ,, ...	6	6·125	54·8 grs. ,,
,, 3rd ,, ...	6	6·25	52·6 grs. ,, = ·158 h.r.
S.F......................	1	4·43	·7 hank roving.
I.F......................	2	5·3	1·875 ,,
R.F.	2	6·1	5·75 ,,
Mule	1	10·4	60's

INDIAN COTTON.

20's RING YARN. Scutcher lap 13½ oz. per yard.

	Hank Roving.	Draft.	Hanks per sple. in 10 hours.	lbs. per machine or delivery in 10 hours.
Card	·138	93	—	177
Draw	·138	6	—	177
Slubber	½	3·6	8·85	—
Inter	1¼	5	8·14	—
Rover	3⅛	5	7·08	8·5 oz. per sple. in 12 hrs.
Ring Frame	20's	6·4	8·85	7·083 ,, ,, 10 ,,
Reel	—	—	—	102·83

20's MULE YARN. Scutcher lap 13½ oz. per yard.

	Hank Roving.	Draft.	Hanks per sple. in 10 hours.	lbs per machine or delivery in 10 hours.
Card	·138	93	—	177
Draw	·138	6	—	177
Slubber	½	3·6	8·85	—
Inter	1¼	5	8·14	—
Rover	3⅛	5	7·08	6.5 oz. per sple. in 12 hrs.
Mule	20's	6·4	6·77	5·416 ,, ,, 10 ,,

CHINESE COTTON.

14's RING YARN. Scutcher lap 13½ oz. per yard.

	Hank Roving.	Draft.	Hanks per sple. in 10 hours.	lbs. per machine or delivery in 10 hours.
Card	·138	93	—	177
Draw	·138	6	—	177
Slubber	½	3·6	7·78	—
Inter	1	4	7·08	—
Rover	2½	5	6·37	—
Ring Frame	14's	5·6	7·61	8·68 oz. per sple. in 10 hrs.
Reel	—	—	—	88·5

JAPANESE COTTON.

14's RING YARN. Scutcher lap 13½ oz. per yard.

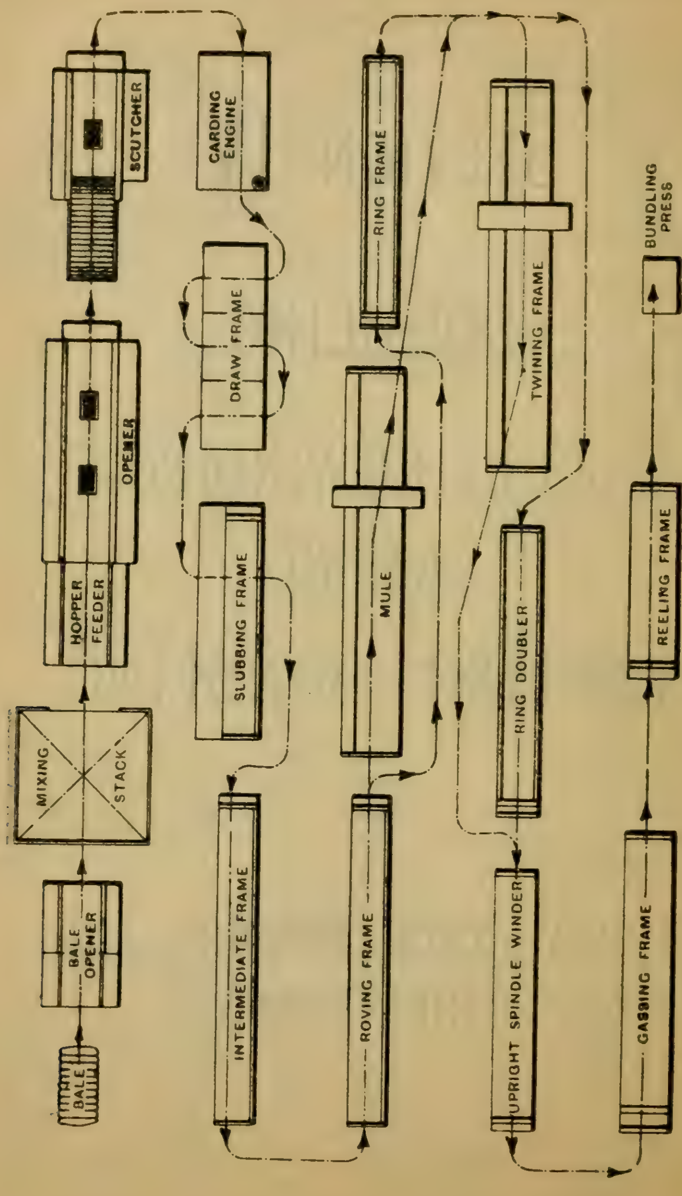
	Hank Roving.	Draft.	Hanks per sple. in 10 hours.	lbs. per machine or delivery in 10 hours.
Card	·138	93	—	159·3
Draw	·138	6	—	159·3
Slubber ...	½	3·6	7·78	—
Inter	1	4	7·08	—
Rover	2½	5	6.37	—
Ring Frame	14's	5·6	7·61	8·688 oz. per sple. in 10 hrs.
Reel	—	—	—	88·5

SECTION IV:

DOUBLING

DOUBLING-WINDING
GASSING
REELING, BUNDLING

THREAD, LACE, HOSIERY, AND
OTHER YARNS



SEQUENCE OF MACHINES FOR RING AND MULE YARN FOR BUNDLING.

DOUBLING

The operation of doubling consists in drawing threads either singly or two or more together from cops or bobbins, twisting them with the required number of turns per inch, usually in the direction contrary to that of the twist of the single, and finally winding upon a bobbin (as in frame-doubling) or into a cop (as in twiner-doubling). The "doubled" or "folded" thread thus produced possesses greater strength, elasticity, and smoothness than a single thread of equal counts: hence it is more suitable for sewing purposes, for lace and heald yarns, and for the warps of strong, heavy fabrics such as fustians, sail cloths, quiltings, etc. A doubled yarn has also a greater fullness and bulk, as required by crocheting, knitting, and hosiery yarns. By doubling it is also possible to produce fancy threads in which different counts, colours, or materials are twisted together—as in gimp, grandrelle, knop, curl, loop, and spiral yarns.

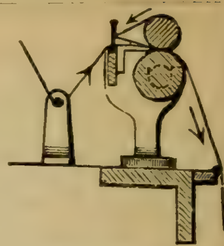
As in spinning, the operation of doubling may either be performed by (1) the continuous, or by (2) the intermittent principle.

(1) The **Intermittent** operation is performed by the Twiner—a machine which resembles in construction a self-acting mule, but having a creel containing cops or cones, each of the latter with two or more ends assembled instead of roving bobbins. Drawing rollers are also dispensed with. The single threads from the cops are doubled and twisted, and again formed into cops. The process is cheaper than frame-doubling, and the resultant yarn is fuller and of a more fibrous nature.

(2) The **Continuous** operation is effected by flyer and by ring doublers—machines similar to flyer and ring spinners, save that they are more strongly built and without drawing rollers. The single threads are taken from cops or ring bobbins, or from cheeses or bobbins prepared by doubling winders, and are doubled either "dry" or "wet." In "wet" doubling the threads are moistened by water before being twisted—a process that induces them to yield more readily to the twisting, thereby forming a more compact and solid thread, which is also made smoother by the more effectual incorporation of loose fibres.

In both the intermittent and continuous methods of doubling the twisting may be done "Dry" or "Wet."

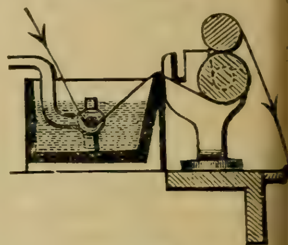
System I.—In Dry Doubling the yarn from the bobbins is passed under a rod and over a glass slit guide between the nip of the rollers and over the top roller. It is then passed round a small glass peg, thence through the rollers again and forward to the doubling spindles.



System I.

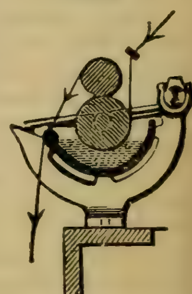
II.—In Wet Doubling, by either method, the yarn passes under a glass rod in a water trough, before encountering the nip rollers or locking slides. The trough containing the water is independent of and is placed behind the nip rollers. The troughs may be either in short lengths or may be continuous with the length of the frame. The rod mentioned is provided with an arrangement by means of which it may be lifted clear of the trough for cleaning and other purposes.

Also illustrates the arrangement of the trough in the "English" system of ring or flyer twisting.



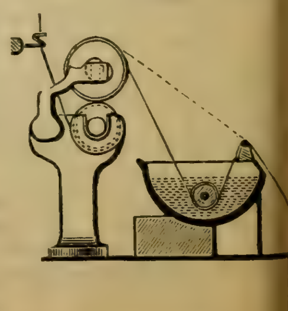
System II.

III.—In the "Scotch" system the rod is dispensed with, and the nip rollers work in the trough. The bottom roller, which is usually of hollow brass, is partly immersed in the water. Provision is made for lifting the rollers out of the trough for the purposes above mentioned. In this system the yarn is considered to become more thoroughly saturated with the water than when rods only are used.



System III.

IV.—American Trough.—In this system the water trough is placed in front of the rollers, and the two or more threads forming the folded yarn are kept separate until they have passed the front edge of



System IV.

the trough, and it is claimed that as the rollers remain dry there is less risk of soiled yarn. The passage of the yarn from the creel round the rollers is exactly as in the English system.

Doubled or **Folded** yarns may be twisted either "Right" or "Reverse," and may be either in the direction opposite to the single twist or in a direction similar to the single. They are usually made from single (known as "doubling weft"), which is spun twist way (or in the direction of movement of the hands of a clock), the amount of twist in the single being midway between the amount inserted in twist and weft. Folded yarn made from this single will ordinarily be twisted in the direction opposite to movement of the hands of a clock, and will be against the single twist. This is termed by the doubler "right way" twisting. The tendency towards untwisting is thereby neutralised, the singles lie closer together, and there is less contraction due to the bending round each other, since they are slightly untwisted during the doubling. The same rule is also followed in the making of "**Cable**" yarns, in which a number of two-fold threads are doubled together, but the final twist is inserted in the direction opposite to that of the first doubling twist, and therefore in the same direction as that of the original singles.

In preparing two-fold for six-fold sewings, the twisting is done in the opposite direction or "Reverse way," and will be made from the same twisted single, putting twist on twist. **Voile** yarns are made in a similar manner. Two-fold reverse yarns of an ordinary number of turns are also made from a single spun weft-way; these will be twisted clockwise, and will be twist against twist.

Contraction.—Reference has been made to the contraction or "take-up" of the single threads during doubling. The extent of this will obviously depend upon their elasticity, the degree of twist in the single and doubled yarns, and upon the relative counts and material of the individual threads, as well as the tension upon each. This contraction naturally affects the length, and therefore the counts of the doubled yarn; but the factors vary so considerably that a general estimate of the amount would be of little, if any, practical value. Usually, however, the singles are spun a little finer to compensate for this take-up. Thus a yarn described as "two-fold 80's" would probably be made by twisting together two threads

of 82's single. *In the following explanations and rules, contraction is neglected.*

Rules for Counting Doubled Yarns.

(1) When the counts twisted together are the same :—

Divide the counts of the single by the number of folds; this gives the resultant count of the doubled yarn. Thus a two-fold 40's yarn would have $40 \div 2 = 20$ hanks per lb.; a four-fold 40's would have 10 hanks per lb.; also three-fold 30's and six-fold 60's would have 10 hanks per lb. That is to say, these yarns would be equal in length and weight to 20's single and 10's single respectively; but they would be distinguished by writing them as 40/2, 40/4, 30/3; or 2/40, 4/40, 3/30, and so on.

If the percentage of take-up be known, it can be taken into account in the following manner. Suppose that in doubling a 4/40's the singles take up to the extent of 4 per cent., what would be the resultant count or number of hanks per lb. of the doubled yarn?

$$\frac{40}{4} \times \frac{96}{100} = 9{\cdot}6 \text{ hanks per lb.}$$

(2) When threads of unequal counts are twisted together :—

Suppose the counts be 60's, 30's, and 20's. It is plain that equal lengths of each count will be consumed; that is, for every 60 hanks of 60's, the same number of hanks of the two other counts will be required. Now,

60	hanks of	60's	weigh	1 lb.
60	,,	30's	,,	2 lb.
60	,,	20's	,,	3 lb.

Making a total weight of 6 lb.

From these quantities 60 hanks of doubled yarn will result, and therefore there will be $60 \div 6$ lb. $= 10$ hanks per lb. Thus we obtain the **Rule:** Divide one of the counts (preferably the highest) by itself and by each of the others; add together the quotients, and divide the same into the selected count.

This Rule may also be used to determine a count that must be doubled with one or more threads to produce a given resultant count. Thus, suppose it is required to find a third thread which when twisted with 60's and 20's would produce a thread of 10's resultant count. As before, 60 hanks of each count would be required to use

up 60 hanks of the finest count: that is, 1 lb. of the 60's and 3 lb. of the 20's or 4 lb. together. But with a resultant of 10's counts, 60 hanks of the doubled yarn would weigh 6 lb.; therefore 2 lb. of the third thread would be required, and its counts must be $60 \div 2 = 30$'s.

The same Rule may again be used to determine the proportion, and therefore the cost, of each count in a doubled yarn composed of different counts. Thus, in the example given, out of every 6 lb. of the doubled yarn there will be 1 lb. of 60's, 2 lb. of 30's, and 3 lb. of 20's. Hence in any given quantity one-sixth of the weight would be 60's, two-sixths 30's, and three-sixths 20's.

The principle of calculating the resultant counts of 2 or more unequal numbers of single cotton yarn twisted together is similar in theory.

If one end of 46's single cotton is twisted with one end of 120's; required, the counts equivalent to two even counts twisted together:—

840 yards of 46's weighs $\frac{1}{46}$ of 1 lb.
840 ,, 120's ,, $\frac{1}{120}$ of 1 lb.

$$\therefore \text{840 yards of 46's and 120's together} = \frac{1}{46} + \frac{1}{120} \text{ of 1 lb.}$$

$$= \frac{120 + 46}{46 \times 120} \text{ of 1 lb.}$$

840 yards (one hank) weighing 1 lb. = 1's

$$840 \ ,, \ ,, \ ,, \ ,, \left(\frac{120 + 46}{46 \times 120}\right) \text{ of 1 lb.} =$$

$$\frac{1}{\left(\frac{120 + 46}{46 \times 120}\right)} \text{ or } \frac{46 \times 120}{120 + 46} = \frac{5520}{166} = 33.25 \text{ resultant counts.}$$

Equivalent to $66\frac{1}{2}$'s/2-fold.

From this calculation the Rule is obtained:—To obtain the counts of unequal singles twisted 2 together, Multiply the counts single together for a dividend, add the counts single together for a divisor. The quotient is the count required.

Another method of obtaining the same result is as follows:—

$$\text{1 lea of 46's weighs } \frac{1000}{46} \text{ grains} = 21.74 \text{ grains.}$$

$$1 \ ,, \ \text{120's} \ ,, \ \frac{1000}{120} \ ,, = 8.33 \ ,,$$

1 ,, 46's and 120's together weighs 30.07 ,,

$$\text{and by a previous rule } \frac{1000 \text{ grains}}{30.07 \text{ grains}} = 33.25 \text{ resultant counts.}$$

In the case of a 3 or more fold yarn composed of uneven counts twisted together, proceed as by above rule for any two of the singles, and with this single counts obtained proceed in the same manner with the remaining single counts. For example: 30's, 40's, and 50's are doubled together; required, finished counts:—

$$\frac{30 \times 40}{30 + 40} = \frac{1200}{70} = 17.14 \text{ and } \frac{17.14 \times 50}{17.14 + 50} = \frac{857}{67.14} = 12.76 \text{ resultant counts.}$$

Equivalent to 38.28/3-fold.

And by the second method:—

$$\left.\begin{array}{l} \frac{1000}{30} = 33.3 \\ \frac{1000}{40} = 25 \\ \frac{1000}{50} = 20 \end{array}\right\} = 78.3 \text{ grains } \frac{1000}{78.3} = 12.76 \text{ resultant counts.}$$

Equivalent to 38.28/3-fold.

The calculations for resultant counts of **Fancy Twisted Yarns** are all subject to the foregoing Rules. For example:—One end of 2/32's grey cotton is twisted into a loop yarn (cotton) 12's black, so that 2 yards of 12's black are used to one yard of 2/32's grey. Now 32's/2 equals 16's single. With one yard of this is used 2 yards of 12's; therefore in 840 yards of the finished yarn there will be:—

840 yards of 32/2 = 16's.
1680 ,, 12/1 = 12's (840 yards being used for forming the loops).

$\therefore$ 840 yards of 32/2 weighs $\frac{1}{16}$ of 1 lb.
1680 ,, 12/1 ,, $\frac{2}{12}$ of 1 lb.
$\therefore$ 840 yds. finished yarn ,, $\frac{1}{16} + \frac{1}{6}$ of 1 lb.

$$= \frac{96}{22} = 8\text{'s resultant counts.}$$

Thus 840 yards of the given fancy "loop" yarn = $\frac{1}{8}$ of a lb., or 1 lb. contains (840 × 8) 6,720 yards

All calculations for resultant counts in Fancy Yarns are approximate only, owing to the shrinkage in length in twisting; but they are sufficiently accurate for practical purposes.

Many fancy yarns are composed of a mixture of cotton and worsted or silk, and the following data may be necessary:—

Cotton numbers are based on			840 yards weighing		1 lb	= 1's cotton.
Worsted	,,	,,	560	,, ,,	1 lb.	= 1's worsted.
Silk	,,	,,	840	,, ,,	1 lb.	= 1's spun silk.

It follows therefore that :—

Cotton counts × 840 ÷ 560 = worsted counts.
Worsted counts × 560 ÷ 840 = cotton counts.

In a "Loop" Yarn calculation of mixed cotton and worsted as follows :—Two ends of 2/32's cotton are twisted with one end of 1/24's worsted. The worsted is used two yards to one of the cotton. What is the resultant worsted number?

$$2/32\text{'s cotton} = 16\text{'s single} = \frac{16 \times 840}{560} = 24\text{'s worsted.}$$

Two ends of 32/2-fold together will therefore equal 12's worsted, one worsted hank of 560 yards of 12's = 1/12 of 1 lb. If the 24's single worsted is used 2 yards to one of the 32/2-fold, then—

$$1120 \text{ yards} = \tfrac{2}{24} \text{ of } 1 \text{ lb.}$$

$$\therefore 560 \text{ yards of } 2/32\text{'s 2 ends together} = \tfrac{1}{12} \text{ of } 1 \text{ lb.}$$

$$1120 \quad ,, \quad 24/1 \text{ worsted} = \tfrac{2}{24} \text{ of } 1 \text{ lb.}$$

$$= \tfrac{1}{12} + \tfrac{1}{12} \text{ of } 1 \text{ lb.} = \frac{12 \times 12}{12 + 12} = \frac{144}{24} = 6\text{'s worsted.}$$

Or, 1 lb. of the yarn finished will contain (560 × 6) = 3,360 yards.

A manufacturer desires a fancy loop yarn of 3,360 yards to the pound. He has 2/28's black cotton yarn in hand, and desires a fancy yarn made with two threads of this, and one end of a grey worsted with a loop exactly as long as the intervening spaces in the yarn. What grey worsted yarn number must he use?

$$3360 \text{ yards per lb.} = \frac{3360}{840} = 4\text{'s cotton number.}$$

$$3360 \quad ,, \quad ,, \quad = \frac{3360}{560} = 6\text{'s worsted number.}$$

The number required being worsted, take the resultant number as 6's worsted, as shewn above :—

$$8/2\text{-fold cotton (two threads together)} = \frac{28}{2 \times 2} = 7\text{'s cotton} = \frac{7 \times 840}{560} = 10.5 \text{ worsted counts.}$$

$$\therefore \frac{10.5 \times x(\text{grey worsted required})}{10.5 + x(\text{grey worsted required})} = 6\text{'s.}$$

$$10.5x = 6(10.5 + x) = 4.5x = 63 = x = 14\text{'s.}$$

Using two yards of 14's to one of the cotton, the counts must be 14 × 2 = 28's.

The foregoing is the basis on English measurement and weight. The **French system of numbering** yarn is based on the Metric system. The relation between fineness and weight or length for weight is exactly the same as in English: that is, a fixed weight and variable length.

The fixed weight employed in the Metric system is 500 grammes, and the number or counts of the yarn is indicated by the number of hanks each of 1,000 metres long required to weigh 500 grammes. Example: If 27,000 metres weigh 500 grammes, the resultant counts are 27's French, or 27 times the unit of length.

The French reel being made 1.428 metre in circumference, then—

1 round	= 1.43 metres	= $56\frac{1}{4}$ inches.
70 rounds 1 lea (échevette)	= 100 ,,	
700 rounds 1 hank (écheveaux)	= 1000 ,,	

Now 700 rounds × 1.43 m. gives only 999.60 metres length of yarn theoretically; in practice the superposition of the threads gives approximately the 1,000 metres.

The proportion existing between English and French counts is:—

English counts—768·08 m (840 yds.) weighing 453 grms. (1 lb.) = 1's English.
French counts—1000 m weighing 500 grms. = 1's French.

$$\therefore \frac{\text{1's English counts} \times 768{\cdot}08 \times 500}{1000 \times 453 \times \text{French counts } (0.847)} = \frac{\text{English counts}}{\text{French counts}} = \frac{1}{0.847}$$

and the Rule—

English counts × 0.847 = French counts.
French ,, ÷ 0.847 = English ,,

Another "constant" number sometimes used is 1.18 used inversely.

Counts English ÷ 1.18 = French counts.
,, French × 1.18 = English ,,

The former is the correct proportion and more accurate.

Standards of Twist.

The amount of twist required in doubled yarns varies, according to their ultimate use, from hard-twisted sewings, heald yarns, and brass bobbin yarns, to the soft-twisted threads for mercerising and hosiery purposes. Before considering the twists that custom recommends in order to obtain these several results, it is necessary to consider the effect of variously twisted singles.

The twists employed by the doubler are in accordance with the result it is desired to obtain in the finished thread. This is a fairly standard list, although the doubler will rarely use a constant multiplier with the square

root of the counts. Occasionally the buyer will stipulate the twist or range of twists he will require. In any case the testing of twists in folded yarn is so simple and so universally adopted by buyers of thread yarns, that the utmost care should be taken that the twists are up to standard and uniform.

In general practice the twists for 2-fold yarns are :—
Turns per Inch—

Counts	2/20.	2/30.	2/40.	2/50.	2/60.	2/80.
Extra hard	—	—	—	—	32	34
Usual	20	22	24	26	28	30
Medium	16	18	20	21	23	26
Mercerising	11	12	13	14	16	19
Soft	—	—	13/14	16	18	22
XX Soft	—	—	10	11	12	13

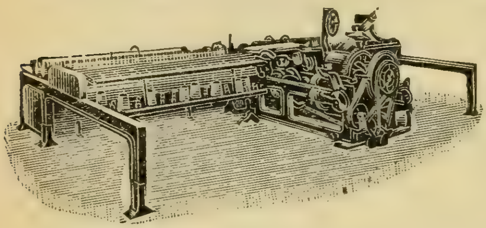
Counts	2/100.	2/120.	2/140.	2/160.	2/180.	2/200.
Extra hard	38	40	42	44	46	50/52
Usual	34	36	38	42	46	50
Medium	30	33	36	40	44	—
Mercerising	23	25	27	—	—	—
Soft	25	28	32	36	39	—
XX Soft	15	17	19	21	—	—

In testing thread for twist, it should be placed on the twist testing machine with the same tension as that of the doubling twisting frame. When the twist has been extracted from ten inches of folded yarn, it will be noticed that the strands of yarn will be slack, indicating that in the twisting process there has been a certain amount of contraction in the length of yarn doubled. Under whatsoever conditions the yarn has been twisted, this contraction will take place. In thread twisted in doubling in the direction reverse to the single twists, and in soft and XX soft threads, this contraction will be at its minimum. The contraction will be at its maximum in threads twisted in the same direction as the single yarn, and in hard-twisted threads. The extent of it will depend upon the elasticity, the degree of twist in both single and doubled yarn, in the drag exerted in twisting, and in the relative counts used. This contraction has an important effect on the counts produced : the more contraction there is the coarser will be the finished counts.

It is a good system to record the contraction from time to time of different threads. Mention has been made of the slackness of the strands after untwisting the 10-inch length. If the increased length be 10½ inches, then the contraction is ½ inch in 10½ inches of single. This contraction will be taken up again in treating of traveller drag in the ring twister.

SELF-ACTING TWINERS.

These machines are made with a creel, spindles, and fallers, with a headstock in the centre on the principle of

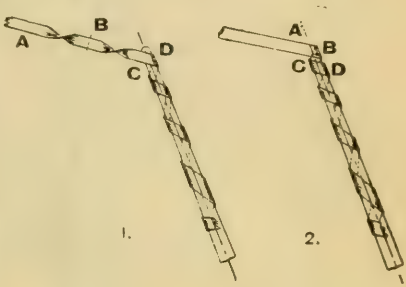


the spinning mule, except that a locking motion takes the place of the rollers. There are two kinds of twiners in common use, known respectively as the "**English**" and "**French**" systems. In the former the spindle rails remain stationary, and the creel containing the bobbins or cops moves in and out. In the latter, the creel is stationary and spindles travel in and out. Both systems can be arranged for either wet or dry doubling.

Creel.—This is usually arranged to receive the cops or tubes direct from the spinning frame, and two or more ends as required are passed to the spindle. The creels may also be arranged to take the yarn from winding bobbins or cones on which the required number of threads have been assembled. The yarn passes over a drag-board covered with flannel, and thence (if for *wet* doubling) through a trough. In *dry* twisting permanently the trough may be dispensed with, but dry work can also be done through the empty trough. The yarn is then passed over a second drag-board covered with flannel, and thence between the open fingers of the locking-plate to the spindle. The operations performed by the twiner are five-fold, and constitute a cycle :—

The first two movements occur simultaneously—the twisting by the spindles and the drawing-off of the yarn. The next movement—that of backing-off—unwinds the spiral of yarn from the spindle-blade. The following movement—that of winding-on and taking-in (of the carriage)—forms the cop. As the carriage recedes, the single yarn is wound off the creel, and is delivered at a regular rate to the spindle for twisting. When the creel has reached its extreme distance from the spindles, the locking-slides close and hold the yarn in position. This is called the **stretch**, which will have been arranged in the

construction of the machine to 60, 62, 64, or 66 inches for cotton, and the carriage is then said to be "out." The spindles thereupon stop, and are caused to revolve in the opposite direction to wind off the spiral. Next the carriage commences to run in and the spindles to begin to revolve in the normal direction, taking up the released yarn, and the cop is built by means of the faller and counter-faller wires. The carriage is now "in," and in this position the locking-slides are opened out and allow the yarn to be delivered for a repetition of the cycle. The movements "out" and "in" of the carriage are spoken of as a "**draw.**"



The twist is put into the yarn on this machine by a process of first winding the yarn on the spindle-blade and then slipping it over the end of the spindle, whereby one turn will be put into the yarn for each round on the spindle. In practice only one round is slipped over the spindle at one operation, and this constitutes one turn of twist for each revolution of the spindle. This will be seen clearly on reference to Diagrams Nos. 1 and 2.

Here the yarn is represented by a narrow tape, which is wound on the spindle from the nose of the cop to the spindle-point in a spiral form. At Fig. 2 the tape is wound on to the extreme point just short of where it would fall off, whereupon the next revolving movement of the spindle is made. In this position there is no twist whatsoever in the tape (yarn); but the tape is folded once on itself from A to B, and also from B to C; and if this be wound off sideways the folds will be removed and no twisting will have taken place. The length of tape (or yarn) from A through B to C is one round of the spindle, equal to one revolution.

If the spindle be revolved in the same direction as that in which the winding-on occurred, the tape will slip off the spindle-point, the folds will be retained, and one turn will be put in the yarn, as shewn in Diagram 1. (This is not to be confused with one turn per inch : it is one turn for each revolution of the spindle, or one turn for

each round wound on the spindle, irrespective of the length of yarn so wound on.) As this process will occur from 8,000 to 10,000 times per minute, according to

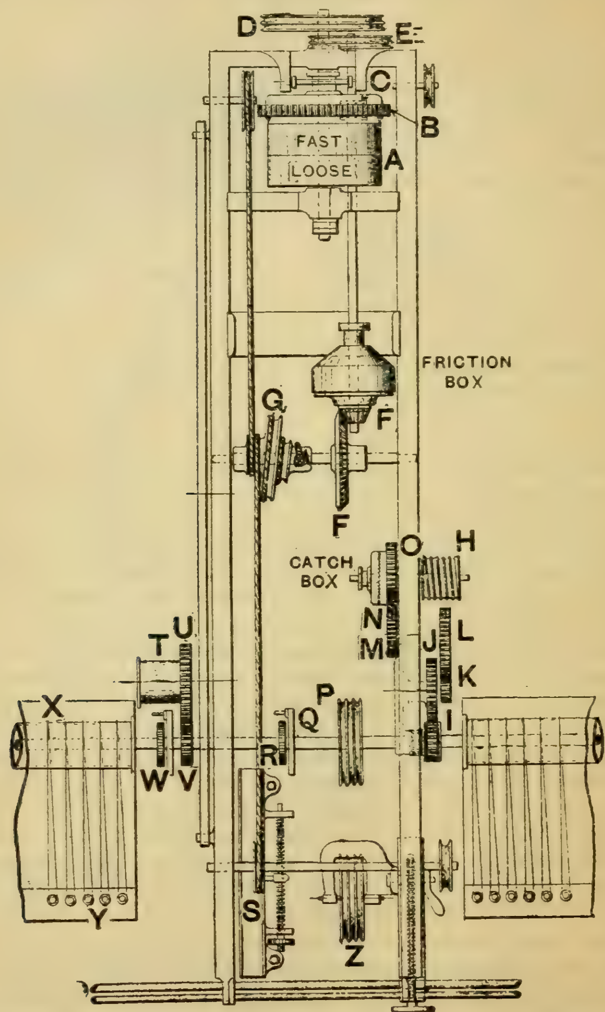


Diagram Illustrating the Parts of the Twiner Gearing that Control the Twist, the "Drawing-out," the "Backing-off," and the "Taking-in."

spindle speed, it is impossible to see it in actual work; but it is simple of proof by slow movements.

The calculation of turns per inch in the twiner—as in all twisting frames—is based on the proportion of the number of inches of single delivered and the revolutions of the spindle in an equal time, and can be made with details of frame standing.

The spindles are driven by means of a rope through a rim pulley, three guide pulleys, and the tin roller wheel. In the illustration, D is the rim pulley or rim-band pulley, P tin-roller pulley, X tin roller, Y wharves, and Z one of the guide pulleys, which also acts as the tension pulley to keep the rim band tight.

The movement of the carriage in drawing-out is also derived from the rim pulley through the tin-roller shaft. On this shaft is fixed the pinion I (called the tin-roller pinion), and through the train of wheels following J the first intermediate, K change-wheel, L second intermediate, M change-wheel, N carrier or idler wheel, O catch-box wheel, and H drawing-out drum.

To find the speed of the spindles and carriage, commence with the main shaft and presume the following particulars :—

Main-shaft revolutions 295 × main driving pulley (36″ + $\frac{1}{4}$″ for belt) ÷ counter-shaft driven pulley (19″ + $\frac{1}{4}$″ for belt) = 555 revs. of the counter-shaft.

Counter-shaft 555 revs. × counter-shaft driving pulley (27″ + $\frac{1}{4}$″) ÷ rim-shaft driven pulley = 930 revs. of the rim-shaft.

Rim-shaft 930 revs. × rim-band pulley (16″ + $\frac{9}{16}$″ for rope) × tin roller dia. 6″ + $\frac{1}{8}$″ for band ÷ tin-roller pulley 10″ + $\frac{9}{16}$″ for band × wharve $\frac{3}{4}$″ + $\frac{1}{8}$″ for band = 10,208 revs. of the spindles.

To find the carriage speed—

Rim-shaft 930 revs. × rim-band pulley (16″ + $\frac{9}{16}$″) ÷ tin-roller pulley (10″ + $\frac{9}{16}$″) = 1,458 revs. of tin-roller shaft.

Worked through the train of change-wheels I to O, the calculation will follow :—

Tin-roller shaft revs. 1,458 × tin-roller wheel 15 teeth × first change-wheel 38 × second change-wheel 15 ÷ first intermediate 80 × second intermediate 90 × catch-box wheel 68 = 25·46 revs. of the drawing-out shaft.

On the drawing-out shaft is keyed the drawing-out drum $5\frac{1}{4}$ inches diameter carrying a band $\frac{9}{16}$ inch diameter. The length of yarn delivered per minute will equal the speed of the drawing-out drum or shaft 25.46 revs. × dia. of drawing-out drum $(5\frac{1}{4} \times \frac{9}{16}) \times 3.1416 = 465$

inches of rope per minute, which is the length of yarn paid out.

The twist inserted will be—

$$\frac{10{,}208 \text{ revs. of spindle}}{465 \text{ inches per minute}} = 22 \text{ turns nearly.}$$

The number of turns per inch can also be obtained from the gearing alone with the frame standing. The principle is exactly the same, but reversed :—

Diameter tin roller $(6'' + \frac{1}{8}'') \times$ drawing-out wheel 68 $\times$ second stud-wheel 90 $\times$ first stud-wheel 80 $\div$ circumference of drawing-out drum $(5\frac{1}{4} + \frac{9}{16} \times 3{\cdot}1416) \times$ second change-wheel (15) $\times$ first change-wheel 38 $\times$ tin-roller wheel 15 $= 21{\cdot}98$ turns per inch.

A constant may be used in calculating the twist or in changing from one to another; and either one of the twists wheels may be considered, or both of them may be taken into account in the same calculation. These are obtained by omitting the twist wheels :—

$$\frac{6\frac{1}{8} \times 68 \times 90 \times 80}{\frac{7}{8} \times 5\frac{13}{16} \times 3{\cdot}1416 \times \text{first change-wheel} \times \text{second change-wheel} \times 15} = 12{,}528.$$

From this constant the following table has been prepared :—

First Change Wheel K.	Second Change Wheel M.													
	13	14	15	16	17	18	19	20	21	22	23	24	25	26
15	64	60	55½	52	49½	46½	44½	42½	40	38	36½	35	33½	32
16	60	56	52	49	46	43½	41	39	37	35½	34	33	31½	30
18	53½	50	46½	43½	42½	39	36½	34½	33	31½	30	29	27½	26½
20	48	45	42½	39	37	34½	32½	31	29½	28½	27	26	25	24
22	43½	40½	38	35½	33½	31½	30	28½	27	26	24½	23½	23	22
24	40	37½	35	33	31	29	27½	26	24½	23½	23	22	21	20
26	37	34½	32	30	28	26½	25	24	23	22	21	20	19	18½
28	34½	32	30	28	26½	25	23½	22½	21½	20½	19½	19	18	17
30	32	30	28	26	24½	23	22	21	20	19	18	17	16½	16
32	30	28	26	24½	23	22	20½	19½	18½	18	17	16½	16	15
34	28	26½	25	23	22	21	19½	18½	17½	16½	16	15½	14½	14
36	26½	25	23½	21½	20½	19½	18	17	16½	15½	15	14½	14	13½
38	25½	23½	22	20½	19½	18½	17	16½	15½	14½	14	13½	13	12½
40	24	22½	21	19½	18½	17½	16½	16	15	14	13½	13	12½	12
42	23	21½	20	18½	17½	16½	15½	15	14	13½	13	12½	12	11½
44	22	20½	19	18	17	16	15	14	13½	13	12½	12	11½	11

TABLE shewing twists obtainable with any change-wheels and gearing.

If 15 turns are required, the Table shews at a glance that the same may be obtained by the use of the following change-wheels :—44 and 18; 42 and 20; 40 and 21; 36

and 23; 32 and 26. These change-wheels may be used in any position. The tin-roller wheel, which also acts as a twist change-wheel, is limited in range to either 15 teeth or 25 teeth, and is a compound wheel. This Table has been calculated with a tin-roller wheel of 15 teeth; then if the 25-teeth wheel be employed instead, the turns per inch will be in reduced inverse proportion of 25 : 15.

Calculations for production are taken from the number of "draws" per minute, and these are usually counted. The formula is as follows:—

$$\frac{\text{Draws per minute} \times \text{stretch in inches} \times 60 \times \text{hours worked}}{36 \text{ inches} \times 840 \text{ yards}}$$
$$= \text{hanks per spindle per hours worked.}$$

and

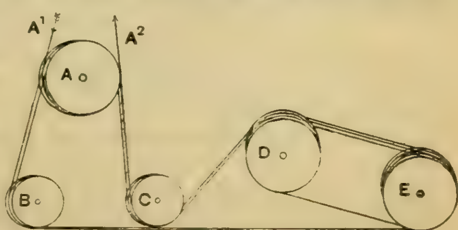
$$\frac{\text{Hanks per spindle} \times \text{number of spindles}}{\text{finished counts}} = \text{lb. for hours worked.}$$

Substituting values

$$\frac{4\frac{1}{4} \times 64 \times 60 \times 10}{36 \times 840} = 6{\cdot}5 \text{ hanks per 10 hours per spindle.}$$

$$\frac{6{\cdot}5 \times 1{,}000}{40/2} = 325 \text{ lb. per frame in 10 hours.}$$

Rim Band.—The various calculations made to ascertain the production—directly by means of the rim band, and indirectly through the medium of the taking-in band—emphasise the necessity for the strictest oversight on these bands if production is to be maintained. The rim band, as the principal driving agent, is provided with three guide and tension pulleys, so that a fine adjustment can readily be made. The rim band passes over five pulleys, of which the driver is the rim band pulley, the driven is the tin roller pulley, and the three guide or carrier pulleys are placed two in the front of the headstock and one (the main tension pulley) at the rear of the headstock. In the sketch herewith, A represents the rim pulley, B and C the guide pulleys at the front of the headstock and below the rim pulley, D the tin roller pulley, and E the tightening carrier pulley. Although the faces of the pulleys have been placed in



the same plane in the sketch, they are not so in actual situation.

THREADING THE BAND.

Commence at A[1], thence pass the band under B to the under side of E, over E and right round D, again under over E and over D to the under side of C, thence right over A, under B, under and over E, over D, under C, and finish at A[2]. The ends A[1] and A[2] are then spliced, and the circuit is completed.

The splicing is an important operation, and no pains should be spared to make a sound and level joint.

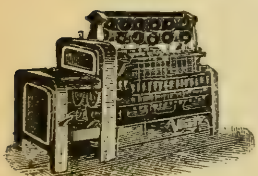
Pulleys.—16 in. dia. × 5 in. wide.

Speeds.—Spindles 7,000 to 9,000 revs. per minute, according to counts of yarn doubled.

Power.—English system, 200 spindles per I.H.P.
French system, 150 spindles per I.H.P.

Production.—40/2 fold, $1\frac{1}{4}$ lb. per spindle.

Floor Space.—For *Length*:—Multiply the number of spindles in mule by spindle gauge and add space taken up by headstock and frame ends, viz.: 52 in. to 62 in., according to maker. For *Width*:—A pair of twiners of 70 in. stretch take up 20 ft.



FLYER AND RING DOUBLING FRAMES.

Description.—The machine resembles the spinning frame, except that there is only one line of rollers, there being no draft. The rollers are made heavy enough to give the requisite nip to the yarn.

Feeding.—The yarn to be doubled is placed in a creel, extending the length of the frame, and running down the centre. It is made to accommodate either mule cops, ring-frame bobbins, spools, or cheeses. The latter are usually made on a winding frame. When mule cops or ring-frame bobbins are used, the yarn is drawn vertically, and a porcupine creel is generally adopted. For the finer counts of yarn a "vertical" creel with revolving skewers is used, so as to minimise the amount of strain on the yarn.

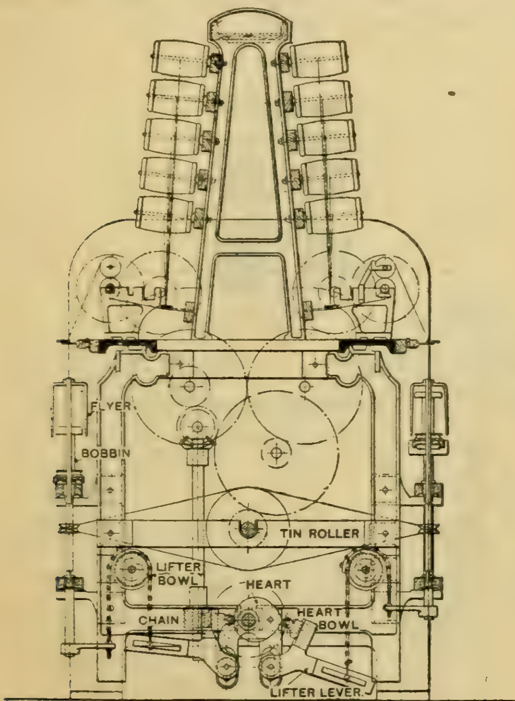
Pulley.—12 in. dia. × 3 in. wide.

Speed.—About 6,500 revs. per minute, according to [counts.

Power.—50 spindles per I.H.P. dry doubling; 45 spindles per I.H.P. wet doubling.

Production.—Of 30/2's, with $15\frac{1}{2}$ turns per inch—$44\frac{1}{2}$ hanks per week of $56\frac{1}{2}$ hours.

Floor Space.—Width, 3 ft. Length, one-half the number of spindles in frame × space between spindles. Add 2 ft. 6 in. for gearing, off end, and width of driving pulley.

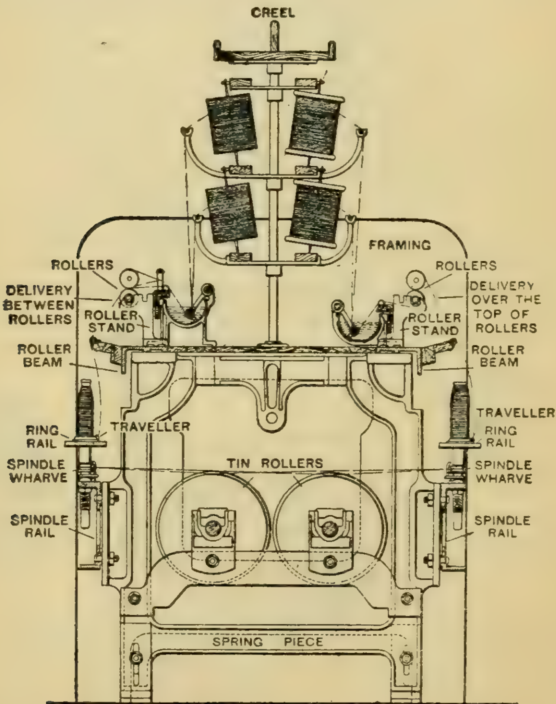


FLYER FRAME, WITH PORCUPINE CREEL.

The Flyer Frame and the Ring Frame have points in common, and the general uses to which they may be applied are identical, in so far as the creels, troughs (if used), delivery rollers, and principles of gearing, are concerned. The flyer frame is the most universal machine. By its means the coarsest of cotton yarns can be assembled and twisted, and by its means alone

the very finest of threads (300's and above) may be produced. The intermediate range of counts can be twisted on either the Flyer or Ring systems, no matter for what subsequent use the thread may be destined. For hard-twist yarns for strength the flyer system is recommended because it affords restriction on spindle speed; and more perfect and regular twist and drag is obtainable.

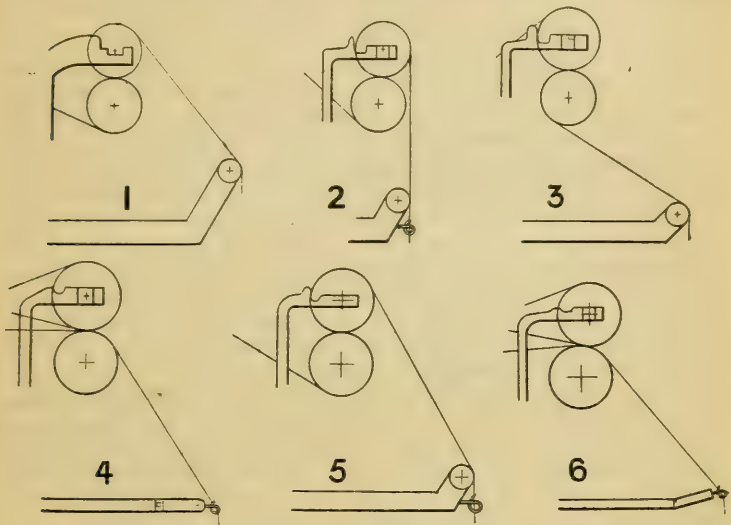
Creels.—These may be made in various forms. The three in general use are—the Cop Creel, the Porcupine Creel, and the Upright Creel.



SECTION OF RING TWISTER, WITH 2-HEIGHT UPRIGHT CREEL.

Another design of creel (the Horizontal) is sometimes used; it is arranged in heights to carry the bobbin or cheese. This creel is similar to a warping mill creel, of a ladder form, whereon the creel pegs fit in notches and may revolve with the bobbin.

Angle of Threads from Roller to Guide.—The angle at which the yarn impinges on the thread-board guide in relation to the roller beam taken as a base, has a distinct effect on the drag. The nearer the rollers are brought forward towards the thread-board (other positions being the same) the lighter is the tension at that part, until (as in No. 2) the friction at that point is overcome, and the yarn becomes subject to an equal



Different Angles of Thread from Rollers to Guide.

tension from the traveller alone. No. 3 shews the method adopted for yarn of hard twist and voile yarns requiring specially heavy drag.

Rotating Thread-guide Rods.—Prevent grooving of the glass rods by the cutting action of the threads, thereby avoiding waste and uneven doubling. The rods are mounted in bearings secured to the thread board of the frame, and motion is imparted to them from the bottom roller by means of driving bands.

Flyer Doubling Frame.—In doubling coarse yarns, such as are used for healds, netting, etc., the flyer system is adopted. The spindles of these frames are extra long, and work in self-lubricating footsteps. For the

heaviest work tapes are employed instead of twisted bands for driving the spindles. The yarn is wound and formed on the bobbins by a chain-and-bowl lifting arrangement, worked by a heart motion, which operates on both sides simultaneously.

Driven Ring Twisting Frame.—Combines the merit of the ring system for speed and the flyer system for quality of output.

The ring and the thread guide mounted thereon take the place of the flyer and ring, and are driven directly from the tin rollers. The bobbin spindles are entirely free from the driven ring, through which they pass up and down without touching. The spindles are of the ordinary self-oiling type (such as are used in ring spinning frames), with the exception that they have no band-pulley or whorl. The spindle is fitted with positive driving nugs, which enter a recess in the bobbin, and (as is the case on flyer frames) the yarn drives the bobbin, with the addition that, in this system, motion is imparted through the bobbin to the spindle, on which it is a good fit. The spindle is also fitted with a flange forming part of an adjustable drag or tension device. This latter consists of the foregoing flange on the spindle, a felt friction washer, and a washer seat with screw adjustment on the fixed base. The rail carrying the spindle is made to traverse up and down similarly to the bobbin rail on ordinary flyer frames.

Single and Double Tin Roller Drives for Spindles.

Single.—Admits of wider frames being used, and is extensively adopted in the United States of America. The system also ensures more uniformity in twist, and is recommended for the doubling of fine yarns. With single tin-roller drive, however, the bands are very short, and unless kept taut there is danger of slipping, which is a deterrent to the twist.

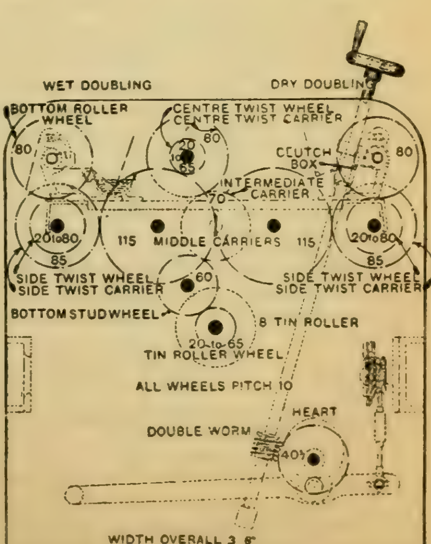
Double.—This system admits of longer bands and higher speeds, but there is a loss of about 5 per cent. in the number of turns imparted to the spindles driven from the off tin roller as against the other side. This defect is not a very important matter where second doubling takes place.

Four-fold Preventers.

Consists of a thin brass sleeve, which is mounted loosely on and revolves with the bottom roller. The internal diameter of the sleeve is 1/32dth of an inch larger and the external 5/32dth of an inch larger than that of the bottom roller. Two flanges are formed on the sleeve, and between these the top roller rests freely. On one of the flanges four notches are cut, at equal distances from each other. Attached to the cap-bar neb is a small bracket, in which is hinged a bent detector wire, the end of which rests lightly on the thread running from the rollers to the thread-board. The weight of the top roller keeps the sleeve in contact with the bottom roller, and thereby causes it to revolve at the same speed. In the event of a thread breaking, the detector wire loses its support, and, in the course of its falling, a part of the shank enters one of the notches mentioned, and in so doing arrests the rotation of the sleeve. The top roller being driven by frictional contact with the sleeve, also ceases to revolve, thus preventing any further delivery of the yarn. The distance that the detector wire travels round its centre in falling is sufficient to carry the broken thread clear, and by holding it in tension prevents it from being caught and twisted in with the neighbouring threads.

Twisting Gearing and Calculations.

The primary object of the gearing is to obtain the twist required in the finished thread, and the principle is the same in whatever build of frame. The arrangement of the train of wheels may vary in a flyer or a ring frame constructed or designed by different makers, and the variation may be for simplicity in changing of the wheels, or for the convenience of the maker; but the underlying principle is always the same. The amount of twist in the thread represents the rela-



tion existing between the revolutions of the spindle and the length of the yarn delivered by the roller.

The tin roller shaft is the driving factor of the gearing and spindles; and on one end of this shaft is the driven factor from the line shaft, namely, the fast and loose pulleys. For calculations for twist and lift, the speed of the frame is not essential. A common speed of the line shaft is 360 revolutions per minute. With a 36-inch diameter drum on this shaft and a 12-inch diameter tin roller pulley or "frame-end" pulley, the calculated speed of the tin roller will be—

$$\frac{360 \times 36}{12} = 1{,}080 \text{ revs. of tin roller shaft.}$$

If the frame is provided with a 9-inch diameter tin roller and the spindles have a 1-inch diameter wharf, the calculated speed of the spindle will be—

$$\frac{1{,}080 \text{ revs. tin roller shaft} \times 9}{1} = 9{,}720 \text{ revs. of the spindle.}$$

This is, however, not the effective spindle speed, and the loss between the calculated and the effective speeds varies considerably. As this loss has an effect on the gearing and on the calculations with the frame standing, it must be taken into account. The amount of slippage occurring between the line shaft and the tin roller shaft does not affect the relation existing between the revolutions of the spindle and the delivery of the yarn, but the slippage between the tin roller and the wharf of the spindle does affect it. Theory and practice teach that the thickness of the driving media (the belt and the band) has a relative bearing on the speeds obtained. A useful rule is to add to the diameter of both driving and driven parts the thickness of the connecting medium. Thus, if the belt is $\frac{1}{4}$ inch thick, add $\frac{1}{4}$ inch to the diameters of both pulleys:—

$$\frac{360 \times 36\frac{1}{4}}{12\frac{1}{4}} = 1{,}065 \cdot 3 \text{ revs. of tin roller shaft.}$$

And if the spindle band is $\frac{1}{8}$ inch thick—

$$\frac{1{,}061 \times 9\frac{1}{8}}{1\frac{1}{8}} = 8{,}606 \text{ revs. of the spindle.}$$

This rule is used in all the calculations following.

TABLE shewing the various factors required for all calculations on the twisting frame, and the relations they hold to each other and their values:—

$$\frac{\text{Revolutions line shaft per minute} \times \text{Diameter driving drum}}{\text{Diameter frame end pulley}} = \left\{\begin{matrix}\text{Revolutions}\\ \text{of}\\ \text{tin centre}\\ \text{shaft}\\ \text{per minute}\end{matrix}\right\} \cdot \left\{\begin{array}{l} \times \left\{\dfrac{\text{Diameter tin roller}}{\text{Diameter spindle wharf}}\right\} = \text{Revolutions of spindle per minute.} \\[2em] \times \left\{\dfrac{\text{Tin roller wheel} \times \text{Middle twist wheel} \times \text{Side or top twist wheel}}{\text{Bottom stud wheel} \times \text{Side or top stud wheel} \times \text{Delivery roller wheel}}\right\} = \text{Revolutions of delivery roller per minute.}\end{array}\right.$$

Revolutions of delivery roller × Diameter of same × 3·1,416 = Inches of yarn delivered per minute.

$$\frac{\text{Revolutions of spindle per minute}}{\text{Inches of yarn per minute}} = \text{Turns per inch.}$$

The wheels in the gearing of different makers' frames vary in position and in number, but if their values be understood, the calculations are simple and are identical in every case. Every train of gearing wheels consists of three driving and three driven. The gearing wheels will be found as a rule to follow this sequence, and may be variously named from their positions, etc. :—

Tin roller wheel (or tin centre wheel) ....Driver
Bottom stud wheel (or shank or jack wheel)..Driven
Bottom (or centre) twist wheel ....Driver

This last drives a series of carrier or idler wheels, which do not affect the calculations, and the details of which are accordingly omitted. The carrier wheels drive the—

Top (or side) stud wheel ....Driven
Top (or side) twist wheel ....Driver
Delivery (or bottom roller) wheel ....Driven

All these wheels (except carriers) can be changed to vary the twist required in the thread; but the drivers or twist wheels will usually be found to supply any range within reason.

Calculations for Turns per Inch.

Revolutions of Tin Centre Shaft = x.

$$\frac{x \times \text{Dia. tin roller}}{\text{Dia. of spindle wharf}} = \text{Revolutions of spindle divided by}$$

$$\frac{x \times \text{Tin roller wheel} \times \text{Middle twist wheel} \times \text{Top twist wheel} \times \text{Circ. of delivery roller}}{\text{Bottom stud wheel} \times \text{Top stud wheel} \times \text{Delivery roller wheel}} = \text{Inches of yarn delivered}$$

= Turns per inch.

Substituting values as follow :—

Tin roller 9 inches dia. wharf 1 inch = Tin roller wheel 30 teeth bottom or centre stud w. 80 t. Middle (or centre) Twist w. 30 t. Top Stud w. 85 t. Top Twist w. 40 t. Delivery Roller w. 80 t. Diameter of bottom or delivery roller $1\frac{3}{4}$ inches, the following formula is obtained :—

$$\frac{x \times 9\frac{1}{8} \times 80 \times 85 \times 80}{1\frac{1}{8} \times x \times 30 \times 30 \times 40 \times 1\frac{3}{4} \times 3{\cdot}1{,}416} = \frac{22{\cdot}28 \text{ revs. of spindles}}{1 \text{ in. of yarn delivered}}$$

or 22·28 turns per inch.

The first two factors are not positive, but an allowance has been made by the addition of the thickness of the

spindle-band to reduce the variation to a minimum. The last one, circumference, or delivery of yarn from the roller, is not positive, inasmuch as it may vary with the drag on the yarn. The intermediate ones (twist and stud wheels) are positive, and it is with these the changes for twist are made. The tin roller (change) wheel is seldom removed, and it is a simple matter to form a "constant" by eliminating the remaining change-wheels, thus:—

$$\frac{x \times 9\tfrac{1}{8} \times 80 \times 85 \times 80}{1\tfrac{1}{8} \times x \times 30 \times \underset{\text{change-wheel}}{\text{bottom}} \times \underset{\text{change-wheel}}{\text{top}} \times 1\tfrac{3}{4} \times 3{\cdot}1{,}416} = 26{,}733 \text{ constant for 2 twist wheels.}$$

If 22/23 turns are required, divide the constant by these turns, and the quotient 1,200 indicates the product of the two wheels which may be used, thus: a 20 and a 60 or 30 × 40.

USEFUL TABLE OF TWISTS.

Top change wheel	20	22	24	26	28	30	34	40	46	50	56	60
Bottom change-wheel... 20	66·9	60·8	56	51·4	47·7	44·5	39·3	33·4	29	26·7	24	22·3
22	60·8	55	51	46·8	43·4	40·5	35·7	30	26·4	24	23·6	20·3
24	56	51	46·4	43·8	40	39	33	28	24	22·3	20	18·5
26	51·4	46·8	42·8	40	36·6	34	30	25·5	22	20·5	18·3	17
28	47·7	43·4	40	36·6	34	32	28	24	20·8	19	17	16
30	44·5	40·5	39	34	32	30	26·2	22·3	19·4	18	16·2	15
34	39·3	35·7	33	30	28	26·2	23	19·6	17	15·7	14	13
40	33·4	30	28	25·5	24	22·3	19·6	16·7	14·5	13·3	12	11
46	29	26·4	24	22	20·8	19·4	17	14·5	12·5	11·6	10·4	9
50	26·7	24	22·3	20·5	19	18	15·7	13·3	11·6	10·7	9·5	8·9
56	24	23·6	20	18·3	17	16·2	14	12	10·4	9·5	9	8·4
60	22·3	20·3	18·5	17	16	15	13	11	9	8·9	8	7·5

A table prepared similar to this one is instructive in many ways. It gives clearly the range of twists obtainable when any two change-wheels are taken into consideration, and it shews graphically the gradation of changes which it is possible to make in the change-wheels. The method of using the table for changes is simple:—

If no change-wheels are on the frame and 20/21 turns are required, we find:—

20·3	turns obtainable by	22	and 60	wheels.
20	,, ,,	24	,, 56	,,
20·5	,, ,,	26	,, 50	,,
20·8	,, ,,	28	,, 46	,,

and that each of the components of these pairs may be placed at either top or bottom change positions.

RULE for production :—

$$\frac{8{,}640{\cdot}7 \text{ revs. of spindle per minute}}{22{\cdot}28 \text{ turns per inch}} = 387.8 \text{ in. per minute.}$$

and $$\frac{387{\cdot}8 \text{ in.} \times 60 \text{ mins.} \times 60 \text{ hrs.}}{36 \text{ inches} \times 840 \text{ yards}} = 46{\cdot}2 \text{ hanks per spindle per 60 hrs.}$$

and $$\frac{46{\cdot}2 \text{ hanks}}{\text{counts produced (say 2/60)}} = 1{\cdot}52 \text{ lb. per spindle per 60 hours.}$$

Such is the theoretical production; it may be formulated thus :—

$$\frac{\text{revs. spindle per min.} \times 60 \text{ mins.} \times \text{hours' run}}{36 \times 840 \times \text{counts produced} \times \text{twist}} = \text{lb. per spdle. per wk.}$$

RULE to obtain production from revolution of delivery roller (when frame is running) :—

Presuming that the actual count of the revolutions gives 65 revolutions per minute, the ratio between these points is a fixed one. Then—

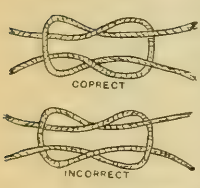
$65 \times 1\frac{3}{4} \times 3{\cdot}1{,}416 = 357{\cdot}5$ in. circumferential delivery of yarn.

Calculation from Actual Revolutions.

$$\frac{357{\cdot}5 \times 60 \times 60}{36 \times 840} = 42{\cdot}56 \text{ hanks per spindle per week.}$$

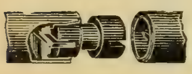
Banding.

Loop Banding.—This should have the loop end steeped in tallow for some days before use; as this is the weakest part of the band, the tallow is intended to render the cotton more pliable, and it has the additional advantage that the opposite end will pass easier through the "loop" in tightening up. This class of banding is most suitable for frames with single tin rollers.

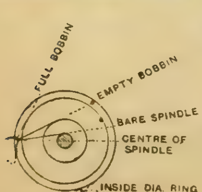


Tubular Banding

Tubular Banding.—In this case the two ends should be tied together with a perfect reef knot. Careless tying will result in a bastard reef knot.



A COUPLING for bottom rollers, for overcoming the difficulties of cleaning out the roller necks and separating the roller into sections, is illustrated alongside.



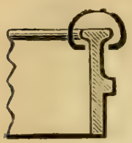
THE Diagram herewith shews the tangential forces exerted at different diameters of the bobbin.

TRAVELLERS FOR WET DOUBLING.

For Wet Doubling; rings $1\frac{3}{4}$ in. and 2 in. dia. Spindles making 7,000 revs. per min.

Counts of Yarn	No. of Traveller 2-Ply.	3-Ply.	4-Ply.	Counts of Yarn	No. of Traveller 2 Ply.	3-Ply.	4-Ply.
4	14	13	4	66	20	20	17
6	15	14	5	68	20	20	17
8	15	14	6	70	21	20	17
10	16	15	7	72	21	20	17
12	16	15	8	74	21	20	17
14	16	15	9	76	21	20	18
16	16	15	10	78	21	20	18
18	17	16	10	80	21	20	18
20	17	16	11	82	21	20	18
22	17	16	11	84	21	20	18
24	17	16	12	86	21	21	18
26	18	17	12	88	21	21	18
28	18	17	12	90	22	21	19
30	18	17	13	92	22	21	19
32	18	17	13	94	22	21	19
34	19	18	13	96	22	21	19
36	19	18	13	98	22	21	19
38	19	18	14	100	23	22	20
40	19	18	14	110	23	22	20
42	19	18	14	120	24	23	21
44	19	18	15	130	24	23	21
46	19	18	15	140	25	24	22
48	19	18	15	150	25	24	22
50	20	18	16	160	26	25	23
52	20	19	16	170	26	25	23
54	20	19	16	180	26	25	23
56	20	19	16	200	27	26	24
58	20	19	16	210	27	26	24
60	20	19	16	220	27	26	24
62	20	19	16	230	28	27	25
64	20	19	17	240	28	27	25
				250	28	27	25

When doubling on rings of $2\frac{1}{2}$ in. dia., travellers a size lighter than the foregoing are required; and for every 1,000 revs. of spindle higher or lower than 7,000, the traveller must vary one size each way.



TRAVELLERS FOR DRY DOUBLING.

For Dry Doubling on spinning section Rings, $1\frac{3}{4}$ in. and 2 in. dia:—

Counts and Ply of Yarn	Traveller	Counts and Ply of Yarn	Traveller	Counts and Ply of Yarn	Traveller
4/2	30	52/2	4	100/2	9/0
8/2	25	56/2	3	110/2	11/0
12/2	22	60/2	2	120/2	14/0
16/2	20	64/2	1	130/2	16/0
20/2	18	68/2	1/0	16/3	30
24/2	15	72/2	2/0	20/3	27
28/2	14	76/6	3/0	30/3	21
32/2	13	80/2	4/0	40/3	14
36/2	12	84/2	5/0	16/4	40
40/2	10	88/2	6/0	20/4	35
44/2	8	92/2	7/0	30/4	38
48/2	6	96/2	8/0	40/4	20

TRAVELLERS FOR TWO DOUBLINGS.

For *Two* Doublings:—

Counts...............	16/9	20/9	30/9	
1st Doubling......	14	15	17	traveller.
2nd "	7	8	10	"

Counts	14/4	16/4	20/4	22/4	28/4	30/4	
Traveller ...	9	10	11	12	13	14	
Counts	20/3	22/3	24/3	26/3	30/3	36/3	40/3
Traveller ...	16	16	16	17	17	18	18
Counts	30/2	36/2	40/2	50/2	60/2	80/2	100/2
Traveller ...	18	19	19	20	21	21	22

To find the Weight of a Set of Bobbins with Indicator as basis:—

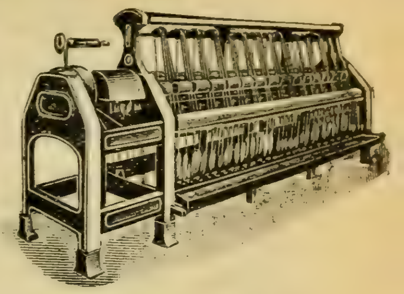
Folds of yarn × number of bobbins × yards indicated ÷ counts × 840 yards = Weight of Set.

In hard-twisted yarns, about 6 per cent. should be allowed for contraction over that indicated as turned off by the rollers.

To find average Length in Yards on a Set of Bobbins:—

Counts × net weight of set × 840 yards ÷ number of bobbins × folds of yarn = Length in Yards.

DOUBLING-WINDING



Function.—To wind several threads together without putting twist in. The winding may be from any convenient number of cops, or ring bobbins on tubes of wood or paper. The yarn is usually wound in the form of cheeses or cones. The use of this machine enables a more perfect yarn to be obtained, by facilitating the removal of faulty places from the singles, and by reducing the tendency to produce what are known as "single places," *i.e.*, portions of the doubled thread in which one or more of the singles are missing.

DOUBLING-WINDING MACHINES.

Types.—(1) Machines with the traverse obtained by a mangle-wheel or a cam motion to form bobbins.

(2) Machines having the rod for the traverse guide worked from a cam at the end of the frame, to form cones or cheeses.

(3) Machines with the traverse obtained by means of diagonally-split drums.

(4) Machines in which the spindle and its connections are entirely self-contained.

(5) Machines in which the traverse is obtained by means of rotary fingers.

(1) **SPLIT DRUM Winders**.—These are of the simplest form and are well adapted for winding coarse yarns at high speeds. They are made with and without stop motions.

The use of these machines can be extended to the winding of fine yarns by the adoption of a patented Tension Regulator, which consists of a double-pointed cam inserted inside each drum, against the surface of which the yarn rests on its way to the spool. The points of the cam represent its largest diameter, and come into contact with the yarn when it is about midway across the drum, thus taking up the slack, which at this period is the greatest. When the yarn is passing through the slit at the side of the drum, it passes over the small diameter of the cam, which in turn gives off the length of yarn

required to compensate for the increased tension that would otherwise occur.

Under these improved conditions the machine may be worked at the following speeds:—

				Revs. per min.
For Counts (say)	8's and 10's	two-fold,	pulley	about 300
,,	20's	,,	,,	400
,,	40's	,,	,,	450
,,	60's & 80's	,,	,,	500
,,	90's	,,	,,	550
,,	100's & upwards	,,	,,	600-700

Speed.—Varying according to quality of yarn wound.

Pulleys.—12 in. dia.

Power.—Single-end machine, 120 drums, = 1 I.H.P. Stop motion winder, 70 drums, = 1 I.H.P. Winding from cops or bobbins.

Production.—From 200 to 300 yards per minute, according to the quality of yarn and number of threads put up.

Length.—Gauge (8¾) × one-half the number of drums + 20 in. for gearing and off end.

Width.—4 ft. 5 in. when winding from end of cops or bobbins; 3 ft. 10 in. when winding from hanks.

(2) **THREAD GUIDE Winder.**—Winds any number of threads up to six upon cheeses, either conical or parallel. The length of traverse may be from 3 in. up to 6 in. and the diameter of the cheeses up to 6 in. Cops, hanks, or bobbins may be put up to wind from. Stop motions are provided which come into action immediately a thread breaks.

Speed.—600 revs. or 160 yards per min.

Pulleys.—10 in. dia. × 3 in. wide.

Power.—120 drums = 1 I.H.P.

Production.—30/2 fold; 104 hanks in ten hours.

Length.—Gauge + 2 in. × half the number of drums and 3 ft. 4 in. for gearing, etc.

Width.—3 ft. 2 in.

(3) **SELF-CONTAINED Winder.**—This type of machine differs from the ordinary quick traverse winder in that each spindle and its connections constitute a separate head; though several heads may be put together to form one frame. Each head is provided with an independent stop-motion which arrests the spindle when a thread breaks or when a spool is full. In the process of winding the thread runs over a guide in a straight line direct from the cop or bobbin to the tube. The coils are laid side by side, touching each other but without over-

lapping or riding. The cheeses may be either conical or parallel and of sizes varying from the smallest spools for sewing machine shuttles to others weighing as much as 50 lb.

Will wind any number of threads up to 12 in one operation. To increase this number a second machine is used, which takes in 5 spools from above and winds the threads they contain upon the tube. Thus, in the case of 12 ends up, the number of threads on this tube will be 60.

Speeds. — Spindles 1,000 to 2,000 revs. per minute, according to size of spools and class of yarn wound.

Pulleys.—3½ in. dia. **Power.**—¼ I.H.P. per head.

Production.—20's to 30's average 1 lb. per spindle per hour.

Floor Space.—4 ft. 8 in. long × 1 ft. 8 in. back to front.

(4) **CAMLESS Winder.**—In this machine the traverse of the yarn across the spool is effected by means of two projecting fingers, which revolve in one direction and drive two similar ones revolving in the opposite direction. The respective movements are obtained by means of small pinions in the centre of each pair. The gear is carried by one finger along a stationary guide-rail, and is brought back again by the finger revolving in the opposite direction. The second finger of each pair merely repeats the action of the first one, so that four traverses of the yarn take place in the course of one revolution of the fingers. Power is transmitted to the driving pairs of fingers by means of bevels from a revolving shaft extending the length of the machine through clutches, which are disengaged when the spools stop; and the rotation of the fingers is also arrested at the same time.

Hints for Care of Quick-Traverse Winders

Whatever type or make is used, attention to details of working parts is essential, both for quality of production, and for the life and well-being of the frame. The following are points to be watched :—

1. Cam box must be partly filled with a mixture of oil and grease, or with thick cylinder oil. This oil must be renewed occasionally, the plug in bottom of cam box being provided for removal of old oil.
2. Note periodically that the change-wheel and carrier-bracket nuts are tight.
3. To minimise wear of cam boss ends, gun-metal thrust collars are provided; any possible wear, however, may be taken up by loosening the cam shaft, locking the set-screw, and adjusting the nuts on the cam shaft end.
4. Oil the drum, driving, and detector shaft bearings, once or twice per day.
5. Oil the top runner bowl pivots periodically, using as small a quantity of oil as possible.

6. Oil the cradle spindle ends after each cheese is wound.

(*Note.*—A small felt pad soaked in oil is very useful for the two last-named operations.)

7. Oil the traverse wires against each carrier bracket.

8. The off-end gear wheels should be covered with tallow or grease.

9. Clean out the detector boxes, traverse-wire carrier brackets, and top runner bowl brackets, periodically, as fluff is liable to prevent the above parts from working satisfactorily.

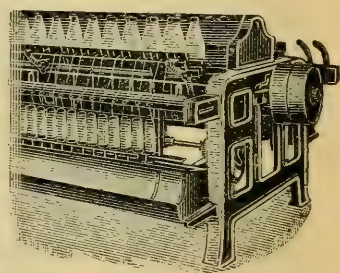
10. Note periodically that the cop skewers point EXACTLY to the yarn guides.

11. Note that the hand lever, when in working position, will not lift more than ⅛th inch off the detector box finger.

12. When changing from certain counts of yarn to much finer or coarser counts of yarn, it is advisable to change the detector wires, and possibly the porcelain end guides.

13. When a number of cradles on a machine are out of use they must be drawn away from the drum, as, when in the "forward" position without a spindle, they rest against the drum shaft, and would very soon wear a groove in same.

CLEARING WINDING



Winding "Bottle"-Shaped Bobbins.—For winding doubled yarns for the gassing frame, and for use in the hosiery, lace, and allied, trades. The mechanism for actuating the traverse in this class of winding is of a two-fold character, controlling the formation of the body or parallel portion as well as the conical part. Both motions should work in unison with one another to produce a compact bobbin that will wind off readily. The action of the former causes the traverse to move at a uniform rate and to lay the yarn in closely pitched successive layers, each traverse extending always to the same point, that is, level with the bottom part of the bobbin; the action of the latter causes the traverse to move to the extent to which the lift rises, and the position at which the mechanism for increasing the speed of the traverse commences. The first layer of the cycle is practically a parallel layer of uniform thickness (the tapering part being only nominal), and each succeeding layer extends a little farther than its predecessor. This process continues until the last layer of the first series is completed, and the approximate full length of the bobbin

is attained. Thereupon a new series of layers commences again, with approximately the shortest length of traverse, and the action is repeated. Thus the layers of yarn are caused to overlap each other and become bound together.

The mechanism for controlling the first-named movement may be on the "heart" or mangle-wheel principle; but that for actuating the tapering motion differs according to the ideas of the respective makers. The following are in extensive use;

(1) Consists of a chain, which extends over a bowl or runner, and is connected to a vertical rod. This latter is fastened to the extremities of bell-crank levers. As the main lifter-rail of the machine is actuated by the lifter-shaft, a stop on the lever encounters a cam and is held thereby; and as the main lifting-lever continues to rise, the bell-crank levers are moved by the pull of the vertical rod mentioned. This holding or stopping point of the lever is continually changed by means of a cam and ratchet-wheel arrangement.

(2) The motion consists of a flat bar or supplementary rail, which is attached to the lifting-rail of an ordinary machine by a series of levers. This bar extends the length of the frame, but is divided into sections, which can be disconnected if required. One of the levers is prolonged downwards, forming a double or bell-crank lever. On the lower extremity is carried a small bowl, and fixed beneath the spindle beam is an arrangement consisting of a combination of a pinion, traversing rack, and shaper-plate. The motion is operated by the movement of the ordinary traverse rail of the machine.

To overcome the liability of the yarn ringing-off during unwinding, mechanism is obtainable in which the principle embodied is that of employing a cam or heart motion for actuating the traverse-rail. The cam is shaped to produce a slow movement of the rail during its ascent and a quick one on the return. Thus as each layer of yarn is put on the bobbin by the former, the quick return of the rail imparts a crossing action to the threads, and binds them together.

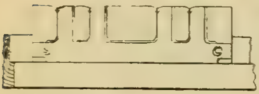
YARN CLEARERS.

Function.—To remove bad ends, thick, soft places, dirty or badly made knots, and any imperfections it may be desirable to get rid of before the yarn is passed forward to subsequent processes. "Clearing" is a neces-

sary process in most varieties of thread produced in a doubling mill; it is also carried out in a lesser degree on the ordinary upright spindle winder with yarn that has to be warped and beamed. It is an advantage to use clearers that admit of adjustment.

Types.—There are quite a large number of devices for this purpose, and among these the following types are in extensive use:—

(I.)—With vertical slits on the adjustable principle. Usually made in plates of four slits each, which can be



adjusted simultaneously by means of an eccentric rod. The latter operates a horizontal plate connected therewith. As the winding proceeds and the bobbins increase in diameter, the yarn changes its position in the slits, and thus prevents wear and tear occurring in one place.

To prevent workpeople from tampering with the adjustment of the clearing slits, it is usual to shield the adjusting nut by a steel guard, and to lock the same in position with a padlock. This arrangement can be simplified by using a specially constructed screw having a smooth round head, in which a pin-hole is made slightly away from the centre. The spanner used is provided with a pin, which is inserted into the hole mentioned, and by working in conjunction with a heel on the spanner it acts as a clamp, and any movement of the spanner in either direction turns the screw the required distance.

In using this system of clearers, the slits for the passage of the yarn are set to and by means of feeler gauges, each gauge numbered and representing a specified number of one-thousandths part of an inch. The following is a list of **Gauges** to which the yarn is set:—

	Good Quality.	Medium Quality.
2/30 and below	12	19
2/31/35	12	17
36/40	11	15
41/45	11	15
46/50	10	14
50/60	9	13
60/80	8	12
80/100	7	10
100/120	6	9

(II.)—Consists of a pair of discs, pressed together by a spring. Each pair represents one clearer, and there is a separate clearer for each bobbin. The discs are per-

forated with holes, and are mounted upon a rod, which is caused to revolve at 3 or 4 revolutions per minute. Each thread passes from its bobbin or cop between a pair of discs, and the friction set up by contact, aided by the springs, is sufficient to free the yarn from objectionable matter and prevent the passage of knots and lumps.

(III.)—A single straight-slit adjustable clearer, having a special arrangement for adjusting the slit. The clearer is made in two parts, connected together by two spring links, which press one part against an adjusting screw in the other part. The action is somewhat similar to that of a parallel ruler.

(IV.)—Consists of a fine steel comb, mounted in a bracket secured to a rod or rail. The frame carrying the comb is hinged, so that the teeth thereof lie close to the guide-rod over which the yarn passes. The course of the yarn to the cops or bobbins is between the teeth of the comb. The deposit of the slub, etc., on the comb is removed periodically by turning the frame on the hinge mentioned, which, as soon as released, returns to its original position by its own weight.

(V.)—Consists of a narrow piece of sheet-metal, with a crow-footed slit, on the front of which is a disc having a number of V's and short slits. One slit in the disc is placed opposite the slit in the body part; the yarn passes through both and on the bottom of the disc-slit. When this becomes worn, the disc is turned on its centre until another slit is brought to working position. The disc contains as many as 26 slits.

(VI.)—In which the clearer has a horizontal slit, and is arranged to be attached to a round rod in front of the slit. The part forming the bottom edge of the slit is fitted on an eccentric stud for adjustment, and is allowed to swivel thereon for the easy removal of any dirt that may become wedged. The clearer is kept in working position by a small weight. (U.S.A.)

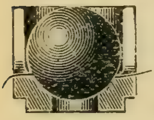
Drag.

The drag or tension on the yarn during winding is usually obtained by passing the yarn over a flannel-covered board; or by threading woollen washers tightly on a steel rod and passing the yarn between the washers.

Revolving Plush Roller.—For use in place of the flannel-covered board in putting drag on and clearing the yarn. The roller is covered with plush, and is driven from the tin-roller shaft at from 8 to 10 revolutions per

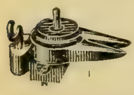
minute. It revolves in the direction opposite to that in which the yarn is drawn, and by means of a worm-and-wheel arrangement is caused to traverse laterally about $2\frac{1}{2}$ inches, so as to equalise the wear of the plush covering.

Ball Drag Arrangement.—Takes the place of the flannel-covered board and brushes. Consists of a series



of porcelain cups (one to each spindle), in each of which a small metallic ball is provided with a V-shaped groove, through which the yarn is guided. The ball in each case rests upon the yarn, and by its weight the necessary drag is imparted. The weight of the ball varies with the class of yarn wound.

Disc Arrangement.—Consists of a bracket attached to the traverse rail of the winding frame, having at the front portion a V-shaped notch for the passage of the yarn and a guide curl to guide the yarn to the bobbin. Between these two points the bracket is recessed to contain a metal washer, through which passes a pin fitting loosely in the bracket, so as to allow the washer to



rotate. The pin is prolonged upwards and carries a second washer, which is also free to revolve. The yarn runs between the two washers, tending to cause them to revolve; but as the lower washer has more friction to overcome than the upper, the necessary drag is put upon the yarn.

The effect of both the two latter drag arrangements is to smooth down the extended fibres and incorporate them in the body of the yarn. The same action also tends to clear off foreign substances, such as broken leaf and the larger "neps."

THREAD KNOTTERS.

Function.—To piece-up broken threads during the winding and rewinding of yarn.

Description.—The implement is held in the left hand of the operator, who passes the two broken threads together over a small guide. By pressing the thumb to the palm of the hand the knot is tied and the ends are cut. All the knot ends are short and uniform, so that no obstruction is presented in subsequent processes. The output of the winder is also increased by its aid. The reverse movement restores the mechanism to its initial position.

Other devices are available for this purpose, which are less costly, but they require more manipulation by the operator.

Knotless Yarns.

In some classes of yarns used in the lace trade knots of any kind are not allowed, on account of the processes subsequent to clearing. Therefore when a breakage occurs in the yarn at the clearing frame, some method of joining the two ends together, other than by knotting, must be adopted. For twofold and threefold yarns it is done by splicing each strand separately on what is known as a "splicing machine." The operation is carried out by young girls in the following manner:—

On each side of the clearing frame a bench is arranged, on which the piecing machines are fixed about 3 ft. apart. When a breakage occurs, or a knot or other imperfection stops the winding, the girl takes both the creel bobbin and the winding bobbin over to the bench on which the piecing machines are fixed. She then places the creel bobbin on one peg and the winding bobbin on the other peg, both of which are fixed to the bench, each on the outside of a hand-wheel. She then draws a short length of the yarn from the creel bobbin and passes it through the slit in a mandrel below the hand-wheel, where it is nipped or held by a spring; then she takes the end of the yarn to the central peg, where it is also nipped. She then turns the hand-wheel in the direction necessary to take the twist out of the yarn between the mandrel and the central peg. The same operation is performed with the yarn from the winding bobbin on the other side of the piecing machine.

The separate strands may then be easily seen, and are taken off the central peg and cut so as to allow one strand from one side to overlap a strand from the other side. These overlappings are made so that no two of them are in the same place laterally, and thus a thick place in the yarn is avoided. By applying a small quantity of an adhesive substance to the overlappings, and rubbing them together between the finger and thumb, a joining of each strand is made. The girl then turns the hand-wheel, puts the necessary twist into the doubled yarn, and the splicing is completed. The creel and winding bobbins are placed on the bench ready for the winding operative to replace them in the winding frame. To prevent any loss of time while the splicings are being made, the winding operative has more bobbins than the spindles she is attending to, and in this way the spindles are always fully employed.

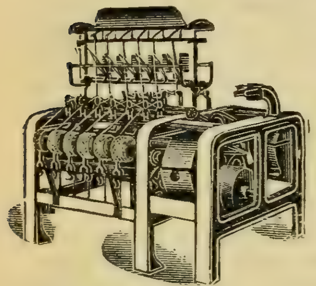
The best results are obtained by using the "Balfe" splicing machine, which is of great service when starting a new set of bobbins, etc. When the ends are simply twisted into each other, bulky joinings are likely.

GASSING YARN

GASSING FRAME.

Function.—To remove the projecting and loose fibres adherent to the surface of the yarn, and thus render it smooth, round, and bright. Yarn so treated is suitable for use in the manufacture of sewing thread and lace; also for mercerising, etc.

Frames with Horizontal Burners.



Description. — These machines are usually worked on the quick-traverse principle. The yarn as it is gassed is wound upon wooden or paper tubes in the form of spools, which can be reeled off endways. The yarn is passed repeatedly through a series of Bunsen gas flames, at a great speed.

The burners used are made in various forms, either atmospheric or plain, and with the flames rising from slits or from a series of holes. It is an advantage if the burners have detachable tops, as these provide better facilities for cleaning.

Pulley.—12 in. dia. Single frame, 120 revs. per min. Double frame, 150 revs. per min.

Power.—About 80 drums per 1 I.H.P.

Floor Space.—Half number of drums in frame × gauge + gearing and off-end space (usually about 2 ft. 7½ inches).

Productions.—

Counts	Revs. of Drum Shaft per minute	No. of times through Light	Hanks per Drum in 10 hours	Lb. per Drum in 10 hours	Hanks per Drum per week of 56½ hours
30's 2-fold	100	9 to 11	43·18	2·878	244
40 ,,	100	9 to 11	43·18	2·159	244
50 ,,	100	9 to 11	43·18	1·727	244
60 ,,	110	9 to 11	47·43	1·584	268
70 ,,	110	9 to 11	47·43	1·355	268
80 ,,	110	9 to 11	47·43	1·185	268
90 ,,	110	9 to 11	47·43	1·054	268
100 ,,	110	9 to 11	47·43	0·948	268
110 ,,	120	9 to 11	51·85	0·942	293
120 ,,	120	7	51·85	0·864	293

Frames with Vertical Burners.

Description.—These frames are made with the Bunsen burners high up in the frame and encased in a split tube, through which the yarn passes. By this system the yarn encounters the flame once only, and the machine can be run at exceptionally high speeds. Split drums impart the necessary traverse to the yarn in forming the spool. This system is well adapted to the use of ventilating or exhausting installations for carrying off the gas fumes.

Approximate Speeds:—

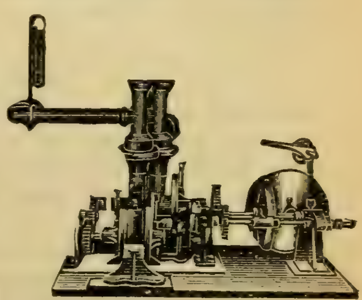
For 8's and 10's two-fold yarn,	pulley		300	revs	per	min.
,, 20's and 30's	,,	,,	,, 400	,,	,,	
,, 40's and 50's	,,	,,	,, 450	,,	,,	
,, 60's and 80's	,,	,,	,, 500	,,	,,	
,, 90's and 100's	,,	,,	,, 550	,,	,,	
,, 110's and upwds. ,,		,,	600 to 700	,,	,,	

(Pulley 7 inches diameter.)

It is an advantage to have gassing frames provided with water gauges, so that each attendant can see at a glance the pressure of gas, and regulate the supply accordingly.

Yarn passed through a gassing frame is slightly reduced in diameter; and when a definite count is required allowance should be made for this reduction.

The cost of gassing yarn may be greatly reduced by mixing air with the gas in suitable proportions, and supplying the mixture to the machines under a pressure to be determined by the user.



An apparatus for this purpose consists of two positive blowers—one for air and one for gas—geared together in the desired proportions and driven by a variable drive, which is governed automatically to give a predetermined pressure in the tanks. The speed of the engine, atmospheric conditions, and pressure in gas main have no effect in altering the mixture or pressure. The amount of gassing required is regulated by the pressure in the pipes.

Removing Dust and Fumes from Gassing Rooms.—In putting down an installation for this purpose, it is

necessary to take into account the following points:—The large number of burners on the gassing frames not only consume a great proportion of the oxygen of the air, but also produce pungent fumes and a quantity of fine fibrous dust. To improve the atmospheric conditions of the room necessitates the passage through it of a large volume of air; but the chief difficulty lies in the fact that this volume of air must be moved at a low velocity, and in such a manner as to cause absolutely no flickering of the lights used in the gassing process. As the flames must on no account be blown aside, and are comparatively easily extinguished by lateral draughts, the air current must be always in an upward direction.

Singeing by Electricity.

Description.—The machine is built up of a series of burners, each of which consists of an alloy of platinum tube, split, and open in the front to admit the entrance of the yarn to be singed. This tube is connected at its terminals with two metallic jaws, the latter being connected with bars carrying the current of electricity. The dust and burnt fibre from the thread is carried away by an exhaust arrangement. As the thread passes from the burner, and before leaving the combustion chamber, it encounters a guide, which serves as a scraper to remove the charred fluff still adhering to the thread. Each burner has its individual arrangement for bringing the winding bobbin into contact with the split drum, simultaneously with the insertion of the thread in the tube of the burner.

REELING

When yarn has to undergo, before weaving, the process of bleaching, dyeing, etc., it is generally reeled into hanks of any convenient size. When intended for export, such hanks generally are of the standard measurement of 840 yards.

Cross Reeling.—In this style of reeling the thread receives a quick traverse over the width of the hank, placing it in successive diagonal layers, and enabling broken threads to be more easily discovered in the winding process. It is the cheapest style of reeling, and makes the least amount of waste.

Figure 8 Tie.—Hanks for bleaching and dyeing generally have an extra band at the opposite end of the

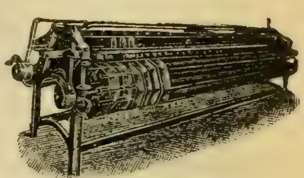
hank from the lease band, to keep the threads straight during the process. This band is tied in the form of the figure 8: hence its name.

Diamond or "Grant" Reeling.—This is a system of cross-reeling which admits of larger lengths being reeled without the danger of entanglement. The diagonal crossings are so open that the tie can be easily threaded in-and-out, which is a great advantage when reeling expensive yarns. There is less waste, and greater production is obtainable in winding-off.

Straight or Lea Reeling.—Is mostly adopted in the case of yarn for export. The threads are laid side by side, and each hank is divided by ties into 7 leas of 120 yards = 840 yards.

Ring Tie System.—Is adopted when the yarn is built up of skeins, and also when the hank is undivided and a movable tie is required for convenience in polishing. The ends of the hank are tied to one another, and the band is passed round to hold the threads together.

REELING MACHINES.



Function.—Winds the yarn into hanks for dyeing, bleaching, bundling, etc., from cops or ring or doubler bobbins.

Types. — Single, *i.e.*, one swift only. Double, *i.e.*, two swifts, one on either side.

Description.—In reeling from cops or ring bobbins the yarn is generally taken from the "nose." But in the case of doubler bobbins, the latter are mounted upon revolving spindles, and the yarn is taken off the side. These machines are also made to wind from "cheeses."

Driving Pulleys.—8 in. diameter × 1½ in. on face.

Speed.—250 revs. per min. from Cheeses, Ring Frame Bobbins, and Cops, endways.

,, 160 revs. per min. from Ring Doubler Bobbins, sideways.

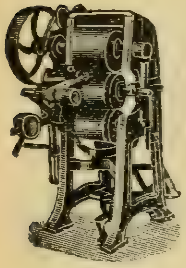
Production.—Reeling from Cheeses, Ring Frame Bobbins, and Cops, 4,500 to 5,000 hanks per 10 hours.

,, Reeling from Ring Doubler Bobbins, 3,000 hanks per 10 hours.

Power.—1 H.P. for 8 reels.

Attendance.—2 girls to 1 double reel.

PREPARING GREY YARNS



This operation is a process of calendering, which imparts a lustre or glazed appearance to the yarn, similar to that of linen thread.

Yarn selected for preparation should by preference be cross-reeled, because it is more readily spread upon the rollers. When reeled on the 7-lea principle, the band separating the leas is liable to cut the yarn while it is under the pressure of the rollers.

Prepared yarn is generally shipped without undergoing any further process.

PREPARING MACHINE.

Function.—Receives the yarn in the hank from a cross-reeling machine, and imparts the necessary lustre thereto by means of rollers.

Description.—The yarn is spread evenly over two rollers working inside the hanks. One of these rollers is supported in a swivel bearing, and the other by a weighted lever arrangement. This latter can be moved outwards for the purpose of putting the required tension upon the hanks. A third roller rests heavily upon the swivel roller, and a fourth works in a similar manner against the under side, the pressure in this case being obtained by means of a movable weighted lever. The swivel roller (which is usually made of compressed paper) is turned outwards when the hanks of yarn are being removed or replaced. The tension roller is provided with a crossing motion, which distributes the threads and insures uniformity of treatment.

Cocoa-nut oil or fat is sometimes applied at intervals to the compressed paper roller. This operation is usually done by hand, but if the grease be applied in irregular quantities there is danger of causing streaky and otherwise faulty hanks. An arrangement has recently been devised which deposits the grease automatically in regular and minute quantities, and which can be regulated to suit the speed at which the machine works.

Pulleys and Speed.—24 in. dia., 20 revs. per minute.

Power.—$1\frac{1}{2}$ to 2 I.H.P.

Production.—According to finish.

Floor Space.—5 ft. 4 in. × 3 ft. 0 in.

DAMAGED HANKS and broken threads are caused by the attendant bringing the weight to bear too suddenly upon

the bottom roller, and can be avoided by recent improvements:—

(1) By means of a "free-wheel" arrangement, in which the bottom roller is driven by the top roller, while the intermediate or cotton roller runs free; and by means of pinions of suitable diameter there is given to the bottom roller, before it comes in contact with the yarn, a slightly less speed than it will have when it comes to be driven by friction from the intermediate roller. At this point its speed increases very gradually, and the catch motion of the free wheel begins to work. The operation of preparing the yarn then continues as in the old machine.

(2) By the application of a rolling weight, which moves gradually along the weight lever until the machine has assumed its normal speed.

One girl will mind about two machines; but, if crossing motions are applied, she may have charge of four machines.

BUNDLING

Single yarns are generally made up in 10 lb. bundles, either long or pressed. The former are mostly used for the home trade, and when the yarn is intended for bleaching, dyeing, etc.

Long Bundles.—Usually consist of 20 hanks divided into two parts by a halch band, and twisted together inwardly to form a knot. A quantity of these knots, sufficient to make a bundle of 10 lb., are tied together the full length, either by twine or by hanks from the bundle. The bundles are then about 26 inches long, and are usually delivered without paper wrapping. A ticket number should be placed on each bundle to indicate the counts.

Pressed Bundles.—Are made up of a series of knots of 10 hanks each, which are hung on a bar or hook and twisted; then doubled ready for fixing in the press. The heads of each knot are placed at one end of the press, to form the face of the bundle. The machine having been charged, and the pressure put on, the bundle is tied up and the pressure is released. (Cotton twine is best for tying purposes, as it is not liable to mildew.) After wrapping with paper, the bundles should be stamped with the counts. For further protection, the bundles should be provided top and bottom with cardboard.

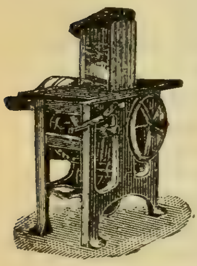
In pressed bundles it is usual for the number of knots to correspond with the counts of yarn bundled, so that whatever the counts pressed, the weight of the bundle is the same. Thus if a bundle contains 200 hanks of 20's, and there are 10 lb. in a bundle, the number of heads in the bundle represent the counts.

In making up **doubled yarn,** the number of heads multiplied by the fold in doubling gives the counts. Thus:—Two-fold 20's would show ten heads, and three-fold 36's twelve heads, etc. On this principle a knot of folded yarn is the same length as a knot of single; but this rule is not always applied.

Sewing Cotton is made up in skeins and marked. For instance, a 10 lb. bundle marked 2/12's 90 × 40 would represent a bundle containing 90 hanks, each hank having 40 skeins of two-fold 12's yarn. The weight of the bundles varies according to the requirements of the market. So does that also of those containing knitting yarn.

Reverse Cable Yarns are generally made up in 5 lb. bundles. The hanks are continuous, and the head of each appears at the face of the bundle, upon which is marked the counts and folds of yarn.

THE BUNDLING PRESS.



Function.—Makes up the hank yarns into bundles of a given weight, and presses them so that they may be packed in small compass for transit.

Description.—The press is generally provided with a table mounted upon very strong framing. The bundling is effected by means of two sets of vertical bars, arranged side by side opposite each other. To one set a further set of bars are hinged. When the machine has been charged with yarn, the hinged bars are brought over and the ends are interlocked with the first set of bars. The pressure required is then brought to bear upon the bundles underneath. When the strings have been tied the pressure is released, the hinged bars are raised, and the bundle is removed to the packer.

Speeds.—60 revs. per min.

Pulley.—24 in. dia., with a 3 in. belt. **Power.**—1 I.H.P.

Production.—With one man and two junior assistants to do the knotting, average counts 20's..................200 bundles of 10 lb. each (or equivalent) per day of 10 hours.

Floor Space.—3 ft. 0 in. × 2 ft. 0 in.

Installation

OF 5,040 SPINDLES FOR DOUBLING AND GASSING 2/60's YARN, TO BE SOLD IN BUNDLES.

2 Quick-Traverse Drum Winding Frames, 130 drums each.
10 Ring Doubling Frames, 504 spindles each.
2 Winding Frames to wind on single-flanged bobbins, 200 spindles each.
4 Gassing Frames on quick-traverse principle, 148 drums each.
6 Double Reels, 40 hanks each. 1 Bundling Press.

If the yarn be not gassed but bundled only, then omit the 4 gassing frames.

The above plant would deal with about 5,000 lb. of yarn.

THREAD, LACE, HOSIERY, AND NEPPED YARNS

SEWING THREAD: PROCESSES.

Sewing Cotton generally undergoes two twistings if the yarn doubled be more than three-fold. In the first doubling, the yarn is twisted in the same direction as that in which it is spun; but in the second, or finishing doubling, the direction of the twisting is opposite to that of the spinning. Two or three-fold sewing cotton is twisted once only, and the twist is in the opposite way from that of the spinning.

In manufacturing sewing thread in the warp, after it has been doubled in (say) three-fold or six-fold, or doubled for crochet purposes, it is usually wound on to warpers' bobbins. From 100 to 360 of these bobbins are placed in a creel, and the yarn thereon is either wound upon beams or is linked into chains, according to requirement. The threads are leased at distances to prevent them from becoming entangled during the dyeing or bleaching.

If the thread is to be treated in the hank, it is reeled directly from the doubler bobbins, or is first cleared in a clearing frame and then reeled.

Dyeing and Bleaching.

From the machines above named, the thread is taken to be dyed or bleached. When it is to be dyed black or a dark colour, it is (as a rule) not bleached, but merely boiled with water until thoroughly softened or wetted. It is then taken to the dyeing machine.

For light colours the thread is sometimes passed through a weak boiling solution of soda ash, then steeped

for a few hours in a weak cold solution of chloride of lime; afterwards it is washed in water, steeped in dilute hydrochloric acid, and finally well washed.

Bleaching.

When the cotton is to be dyed in bright colours, it is invariably bleached more or less thoroughly. For some shades it suffices merely to boil-out the yarn in a weak solution of soda-ash, when it is washed, steeped for a few hours in a weak solution of bleaching powder, again washed, soured with dilute hydrochloric acid, well washed, and soaped. Other shades can only be satisfactorily produced on a full-bleach bottom.

The full bleach for white cotton sewing thread consists in the following series of operations:—

(1) The yarn is prepared for the boiling, hanks being linked together to form a continuous chain of a convenient length, and warps being chained by machine.

(2) 1st Boil: The ordinary vomiter kier with a solution of caustic soda, the strength of which is regulated according to the counts of the yarn under treatment.

(3) Taken from the kier, the yarn is washed, and plaited into a cistern provided with a false bottom, and having a well underneath containing a solution of bleaching powder, at a strength according to the counts. It is also provided with a transportable perforated cover, or sieve, which is placed over the cistern when filled to the proper height. The chemic liquor is then caused to circulate therein by means of a pump from the well on to and through the yarn, back again to the well.

(4) The yarn is transferred into souring cistern, also provided with a sieve cover, where it is well washed and

(5) Soured with a dilute solution of sulphuric acid, which is contained in an underneath well, and is caused to circulate through the yarn by a pump.

(6) Before being removed from this cistern, the yarn is well washed with water.

(7) Washed again through washing machine.

(8) 2nd Boil: Vomiter kier, with a solution of black soap and soda, or of caustic soda.

(9 to 13) Repetitions of operations 3, 4, 5, 6, and 7.

(14) Hydro-extracted.

(15) Stocking or Dumping: Stocks 3 ft. long by 2 ft. wide and 2 ft. deep, each provided with a large wooden mallet (as employed in the bleaching of linen). The yarn is beaten in the stocks with a hot solution of soap.

(16) Worked in washing machine.
(17) Hydro-extracted.
(18) Blueing: Done in machine provided with squeezing rollers and filled with water and the required amount of extract of indigo or ultramarine.
(19) Hydro-extracted.
(20) Dried in the stove.
(21) Hung in cooling shed.
(22) Stretching machine, where the yarn is passed over hot rollers to take out the curl and excess of moisture acquired in the cooling shed.
(23) Taken to warehouse, where the yarn is classified and made up into lots of convenient sizes.

MACHINES USED IN MANUFACTURING SEWING COTTON SIX-FOLD.

WARP SYSTEM.

Stop Motion Winder.

Winds the yarn from the spun cops or bobbins two-fold on to cheeses or doubler bobbins.

Speed.—About 60 revs. **Pulleys.**—12 in. dia.

Doubling Twister.

(Either ring or flyer system.) Takes the doubled yarn from above frame and twists the strands together in the same direction as that in which they were spun.

Clearing Frame.

Removes from the yarn all lumps and extending ends before receiving the second twisting.

Speed.—140 revs. per min. **Pulleys.**—12 in. dia.

Doubling Twister.

(Either ring or flyer.) Takes three of the strands above twisted, and imparts the final doubling to form six-fold thread. The twist put in by this machine is in the direction opposite to that in which the yarn has been spun.

Winding Machine.

Winds the thread from the doubler bobbins on to warpers' bobbins, for the chaining and linking machine or for the beaming machine.

Speed.—140 revs. per min. **Pulleys.**—12 in. dia.

Chaining and Linking Machine.

Forms the twisted threads into a chain, then links them into bags or baskets ready for bleaching or dyeing. These machines save the expense of beam warping, are

automatic, and have a stop-motion to arrest the machine when a thread breaks.

Speed.—125 revs. per min. **Pulleys.**—10 in. by 3 in.
Floor Space.—7 ft. 3 in. by 6 ft. **Power.**—½ I.H.P.

Vomiter Kier.

The thread yarns, in the form of linked chains, are packed into this vessel, where they are boiled for some time with a solution of alkali. Capacity, 2,000 lb. yarn.
Floor Space.—8 ft. × 6 ft.

Bleaching Cistern.

The chain of thread from the above machine passes over winches into a bleaching kier, on one side of which is a well containing the chlorine or bleaching mixture, and on the other side a well of sulphuric acid for the souring. The cistern having been charged, the liquid from the first tank is passed through the contents, after which the latter are well washed. The souring process next follows; it is effected by pumping the liquid from the second well, and washing again follows.

Washing Machine.

Provided with guide rollers and squeezers and a plentiful supply of water.
Speed.—110 revs. **Pulleys.**—12 in. by 2 in.

Dumping Machine.

Used for fulfilling the functions of the stocks with mallet, and to force the liquor at this stage into the threads, thereby ensuring uniform treatment throughout.
Speed.—50 revs. **Pulleys.**—30 in. by 3½ in.

Blueing Machine.

Provided with guide-rollers and squeezing-rollers, through which the yarn is passed to receive the required tint.
Speed.—100 revs. **Pulleys.**—12 in.

Hydro-Extractor.

Extracts from the yarn by centrifugal action as much sa possible of the liquor.

Drying Machine.

When used in substitution of hot-air drying, the Drying Machine is generally made with seven or nine steam-heated cylinders, so arranged that the thread passes under and over the surface of each, and is completely dried. From this machine the thread is wound again on to flanged beams for polishing. The warp passes over the cylinders at about 190 ft. per minute.
Speed.—100 revs. **Pulleys.**—18 in. by 5 in.

To complete the above installation it is necessary to provide the following:—

An iron tank, in which to prepare the solution of alkali for supplying the boiling kier.

A tank provided with agitators, in which to prepare a strong solution of the bleaching powder.

A jacketed pan with stirrers, for the compounding of the polishing mixture.

Polishing Machine.

The beams containing the doubled warp threads are placed behind this machine, and the threads thereon are passed through a trough containing the necessary polishing mixture. After passing through a pair of squeezing rollers, the threads are brushed by cylindrical brushes, after which they are wound upon bobbins to be taken to the spooling machine. There are usually two brushes and one beater, or (in some cases) 3 single brush rollers. The creels are arranged to suit the number of ends or strands in the chain.

Spindles and Cylinders	Floor Space (Feet)	Pulleys (inches)	Speed Revs. per min.	Production in Ten Hours.	
200 (3)	28 x 5½	14 x 3½	600-800	100 to 150 lb.	30's 3-cord
200 (1)	24 x 5½	18 x 3¾	350	150 to 200 lb.	36's 6-cord
300 (3)	30½ x 5½	14 x 3½	600-800	150 to 200 lb.	30's 3-cord
300 (1)	27 x 5½	18 x 3¾	350	220 to 250 lb.	36's 6 cord
360 (3)	31½ x 6½	14 x 3½	600-800	180 to 225 lb.	30's 3-cord
360 (1)	28 x 6½	18 x 3¾	350	250 to 300 lb.	36's 6-cord
98 (3)	19½ x 5½	18 x 3¾	600-800	50 to 75 lb.	30's 3-cord
98 (1)	17 x 5½	18 x 3¾	350	100 lb.	36's 6-cord

NOTE.—The above Floor Space measurements include room occupied by creel in front of starch trough. When used with beam in place of creel, the Floor Space should be reduced accordingly. I.H.P. 2½ to 5.

Automatic Spooling Machine.

These machines are usually made with 10 heads, and are adapted for dealing with large quantities of thread of one counts and length, and are both expeditious and economical.

Speed.—280 revs. per min. **Pulleys.**—14 in. by 3 in.

Floor Space.—14 ft. by 3 ft.

Production.—36 gross of 200 yard spools per day.

When the thread is of a varied kind, and in the case of dealing with smaller quantities, the machines used are generally on the hand and semi-automatic principle.

HANK SYSTEM.

When the doubled yarn is to be treated in the hank, the hanks are tied loosely together, so as to form a continuous link chain for passing through the bleaching range, the treatment being practically the same until the polishing process is reached.

Polishing Machine.

This is worked on the upright principle, and takes in 54 hanks. The brush cylinder is usually 2 ft. 2 in. wide, and has from 10 to 30 brushes, according to the size of the machine.

Speed.—350 revs. per min. **Pulleys.**—14 in. by 3¾ in.

Winding Machine.

Winds the yarn from hanks on to bobbins. Is worked on the drum principle, containing from 30 to 100 drums.

Spooling Machine.

The finished thread is spooled on the machine above described.

SOFT OR UNGLAZED THREAD.

When the warp threads, handled as above, have to be spooled in the soft or unglazed state, the beams containing the doubled yarn are taken directly to a "beam or bobbin" winding machine.

Winding Machine for Warp.

These machines usually contain 300 spindles, and wind on to bobbins, with a 5 in. or 6 in. traverse, as required.

Speed.—100 revs. per min. **Pulleys.**—12 in. by 4 in.

Power.—1 I.H.P.

Floor Space.—17 ft. 6 in. by 5 ft. 6 in.

Winding Machine for Hanks.

Is on the drum principle, and usually contains about 100 drums.

Speed.—240 revs. per min. **Pulleys.**—12 in. by 3 in.

Power.—2 I.H.P. **Floor Space.**—34 ft. by 6 ft.

Spooling Machine.

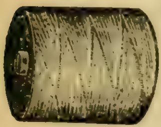
Particulars as above.

Bobbin-to- Bobbin Polishing Machines.

These machines are made to take in 32 threads and 50 threads respectively. Are specially adapted for polishing small lots of thread or twine that have been dyed or bleached in the hank, and thereafter wound on to bobbins or tubes ready for sizing and polishing on these machines.

CROCHET AND LACE YARNS.

Crochet Cotton is doubled twice, but the first doubling is in the opposite direction from that in which the yarn has



been spun, while the second doubling is in the same direction. In other words—The twisting for crochet yarn is in the opposite direction from that of sewing cotton.

The quality and strength of the above products are determined by the quality of the spun yarn and the number of strands twisted together.

Lace Yarns.—Doubled yarn for use as warp is invariably weft, spun twist way but doubled weft way. Two or more threads are first wound from the cops on to cheeses or bobbins. After doubling, the yarn is cleared and (if necessary) gassed. It is then finally made into balls, chains, or beams, for delivery to the user. Doubled weft for bundling is first wound as above, then twisted on the doubler, and finally reeled into hanks for the preparing and finishing machines.

STRENGTHS OF DOUBLED YARN.

The following are the average breaking strengths of 6/cord yarn for thread :—

Counts.	Fold.	Lb.	Counts.	Fold.	Lb.
32	6	11.6	70	6	5.8
36	6	9.2	80	6	5.5
40	6	8.13	100	6	4.5
46	6	7.5	110	6	4.1
50	6	7.3	120	6	3.8
60	6	6.6			

DYEING OF THREAD.

Single-box Chain or Warp-Dyeing Machine.

A single compartment, provided with guiding rollers and a pair of adjustable squeezing-rollers.

Speed.—40 revs. per min. **Pulleys.**—16 in. by 4 in.
Floor Space.—12 ft. by 4 ft. 8 in.

Multiple-box Machines.

Similar in construction to the single-box machine, but composed of two or more compartments, each with squeezing-rollers.

BALLING MACHINE.

Function.—To wind cotton and other fibrous threads into balls with or without cardboard or wood centres.

Description.—Is equipped with a set of flyers and a set of spindles, which are driven positively, and are under the control of stop-motions. The size and shape of the

balls are determined by a cap fitted on each spindle, round which the ball is formed. These caps are detachable, and may be changed to suit requirements. The ticketing is done by special motions, which operate automatically and can be regulated at will. Mechanism is also provided to wind the interior of the ball with an open mesh, which on the last few layers may be altered to a close mesh.

Production.—12-spindle machine—20 gross of crochet thread balls in 10 hours.

Floor Space.—6 ft. 6 in. × 3 ft. 9 in.

Pulleys and Speeds.—8 in. × 2 in.—400 to 500 revs. per minute, according to size of balls.

TICKET NUMBERS AND YARN COUNTS.

The ticket numbers on spools of cotton express the number of "hanks" that are required to wind a pound (lb.). The finest spinning rarely exceeds 300 hanks to the pound, while in the very coarsest there is about half-a-pound in each hank. The more common qualities (that is, those from which sewing thread is usually made) run from 10 to 50 hanks to the pound, and the spools on which it is wound are numbered from 10 to 50 accordingly.

2 Cord Ticket Nos.	Yarn Nos.	3 Cord Ticket Nos.	Yarn Nos.	4 Cord Ticket Nos.	Yarn Nos.	6 Cord Ticket Nos.	Yarn Nos.
20-24	— 20	10-12	— 20	10-12	— 24	10-12	— 36
30-36	— 24	16	— 22	14-16	— 28	14-16	— 40
40	— 28	20	— 24	18-20	— 32	18-20	— 46
50	— 32	24	— 26	24	— 36	24	— 50
60	— 36	30	— 30	30	— 40	30	— 60
70	— 40	40	— 40	36	— 46	36	— 70
80	— 46	50	— 50	40	— 50	40	— 80
90	— 50	60	— 60	50	— 60	50	—100
100	— 50	70	— 70	60	— 70	60 70	—110
		80	— 80	70-80	— 80	80	—120
		90	— 90	90-100	— 90	90-110	—130
		100	—100	110-120	—100		
		120	—110	130-140	—110		
				150-160	—120		
				170-180	—130		

Wet Doubling is invariably employed for sewing cottons, as it enables the threads to be drawn flat and tightly together—whereas dry doubling would give a looser and more porous yarn, with fluffy projections of fibre ends.

RECIPES AND NOTES.

Oil Wax Cake.—Dissolve 30 lb. yellow wax in 30 lb. castor oil. When the temperature reaches 180 deg. and the wax is dissolved, it is ready to be put in moulds, and should stand 24 hours. When taken out, it should be kept cool and free from dust of any kind.

Grey Thread Polish.—16 gallons of water, at 170 deg.; 9 lb. starch, mixed in cold water; and 1 lb. yellow wax. If a bright polish is required, 1 more gallon of water, at 170 deg., should be added.

Black or White Thread Polish.—15 gallons of water, 7 oz. white soap, and 16 oz. hard paraffin. Boil until well dissolved, then add 9 lb. Indian corn starch, previously made into a thin pulp. Boil together until well mixed; then cool and use.

White Thread Polish.—17 gallons water, at 175 deg.; ¾ lb. oil soap, cut into small slices and stirred until properly dissolved. Add 7 lb. starch mixed with cold water. Pour into the boiler the liquid starch, then add 12 oz. paraffin wax, 8 oz. white ditto, and 5 oz. castor oil. The mixture should not be used quite cool.

White Sewing Cotton Polish.—16 gallons of water, 6 lb. starch, 6 oz. white wax, 5 oz. yellow wax, 7 oz. pale white soap, and 2 oz. spermaceti. Mix as above.

Testing Quality of Wax.

Boil 10 lb. wax. If it become liquid at 170 deg. Fahr., the wax is good, and may be used with safety; but if it have a white lather like soap suds, it is unfit for use.

Testing Quality of Starch.

The starch must be absolutely dry before testing. Take a firm hold of a quantity in the hand. If, when released, it does not spread out like flour, it is bad, and will not keep. This is caused by damp, which turns it sour and makes it cake after pressure. If starch tends to sour in the machine troughs during working hours, put in a piece of washing soda about the size of a walnut one piece for every gallon of liquid.

Polishing Thread.

Thread must be treated, according to its thickness and lustre, with careful attention to four points: Correct sizing, exact tension in winding, and careful brushing and drying. Any variation produces unsatisfactory results. The natural rotundity and elasticity of the thread should be preserved, and it should also possess

the smoothness and softness of polish essential in thread for use in the sewing machine.

Double-twisted sewing cottons are stronger, more supple, and softer, than single-twist yarns of otherwise equal quality. Also they produce a cleaner, flatter, and softer stitch. In order to give them the same strength, etc., the latter are often finished and glazed.

"NEPPED" YARN.

The "neps" required in the production of "nepped" yarn are first prepared on an ordinary roller-and-clearer carding engine, with the following alterations:—The casing under the taker-in is plain. The fancy roller usually employed is done away with, as are also the casing under the cylinder and the stripping comb and doffer. The coilers and sides of the coiler covers, and the covers at the sides and ends of the machine framing, are no longer necessary. The laps put up at the machine are of the ordinary kind, taken from the scutcher.

Setting.—The setting of the card governs the size of the neps made: that is to say, the closer the setting, the smaller the neps. For ordinary purposes the setting should be two gauges thick.

Wire.—Cylinder, 40's. Doffer and rollers, 80's. All needle-pointed. Licker-in has saw-tooth clothing.

Speed.—Cylinder, 170 revs. per minute.

The centrifugal force of the cylinder in revolving throws the neps of cotton outwards, and as they fall they are deposited into a trough provided for the purpose and placed on the floor underneath the cylinder.

A second machine is employed for carding the plain cotton along with the neps. It is also of the roller-and-clearer type, and is provided with an apron-feed. The lattice for the feed is covered with a closely woven fabric. To prevent the neps from falling through the machine, the casing under the cylinder and the taker-in are made blank. Ordinary scutcher laps are fed to the machine, and are placed between guides, the neps being fed on the lattice behind the roller lap. The neps and plain cotton are fed to the machine in equal quantities; and to ensure the correct proportions the lattice for receiving the neps is marked every 36 inches.

Drawing.—The sliver from this machine is put up at the draw frame along with plain slivers from other cards, the proportion being 5 plain to 1 nepped sliver. Care should be taken to have the latter the same weight per yard. The slivers pass through the draw frame to ensure

the right doubling. The above proportions may be varied from two to four or three to three, according to the number of neps required.

Speeds.—The finished slivers are put up at the slubbing frame in the usual manner, followed by intermediate and roving frames. In each machine the spindle speed is a little quicker than usual, to ensure sufficient twist being put into the rove for carrying the neps through.

Spinning.—On the ring principle. Also the spindles in the frames have a slightly increased speed.

The above arrangement may be varied by placing a plain sliver and a nepped sliver in the creel, and running them together. In this case the proportion of neps would be reduced by one half.

Counts.—Nepped yarn is generally spun in counts ranging from 16's to 30's. Ordinary numbers in "travellers" are used.

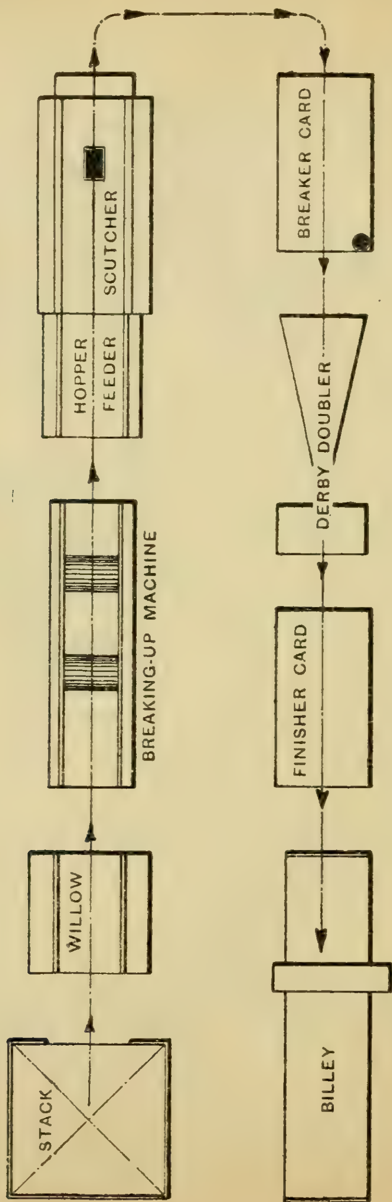
DOUBLE TWISTED SINGLE YARN.

This yarn is often used in place of two-fold single, chiefly in the manufacture of lace. The yarn for double twisting is usually of fine or medium fine counts, soft, spun weft-way on the mule. It possesses almost the strength and appearance of double thread. After leaving the mule, the yarn is wound on bobbins or cheeses. It then receives its second twisting—on a wet doubler. The yarn, being first spun weft-way, resembles two-fold in appearance, inasmuch as the latter is first spun twist-way and doubled in the reverse direction.

Sometimes this yarn is put through a clearing frame, both before and after it receives the extra twist in the doubling frame.

60's double twisted yarn is used instead of 120's two-fold.
65's ,, ,, ,, ,, ,, 130's ,,
70's ,, ,, ,, ,, ,, 140's ,,
and so on.

Yarn for Motor Tyre Cloth.—Is usually made from yarn 30's to 34's counts, doubled 11 or 12 fold. In winding the 11 or 12 single threads on the doubling winder on to cheeses or bobbins, care should be taken that the tension on each individual thread is uniform with the remainder: otherwise the twisted threads from the doubling frame would be uneven, and when woven into the fabric and tested would shew a variation in the elasticity of the cloth, which is a serious defect in this class of fabric.



SEQUENCE OF MACHINES FOR OPENING, PREPARING, AND SPINNING COTTON WASTE.

SECTION V:

COTTON WASTE
WADDING, BANDING
WEBBING, ETC.

COTTON WASTE

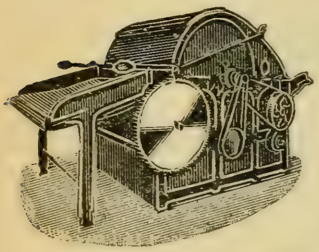
COTTON WASTE MANUFACTURE.

The waste thrown off in the process of cotton spinning may be utilised in a variety of ways, if it be properly dealt with in the preliminary operations. Certain portions may be worked up again in the mill in which it is made; or, in its loose state, it may be converted into wadding, gun cotton, etc. Its principal use, however, is in the manufacture of sheetings, flannelettes, cotton blankets, quilts, sponge cloths, etc., in the production of which complete installations of machinery are employed.

COTTON WASTE MACHINERY.

Willowing Machine.

For opening and cleaning waste and delivering it in a loose state ready for subsequent operations. The machine



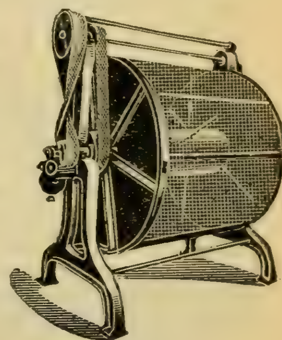
is usually provided with a lattice feeder to ensure the waste entering the machine uniformly the full width of the cylinder. The feed-rollers are driven intermittently, so as to allow the charge of cotton to remain in the machine any predetermined length of time. This machine is sometimes fitted with a dirt-remover, consisting of a wrought-iron scroll, which, by revolving under the machine, conveys the dirt into a receptacle placed outside. Over the latter is a bucket elevator for lifting the accumulated dirt and depositing it into a box or bag.

Dust Receiver.

For dispensing with fans and settling chambers in dealing with the dust and dirt from soft waste from the willowing machine. Consists of a series of air filters and settling chambers, with outlet valves for the discharge of the cleaned cotton. As the dirt is cleaned out of the good material by the willow, the fan of that machine blows it along tubing to a wind-box in the apparatus. From this box the same air pressure blows it into flexible sleeves, which by means of worm-and-wheel gearing are made to open and close alternately. The dirt then falls from these sleeves into the hoppers, each of which con-

tains a bladed worm for conveying the dirt to the outlet valves, to be delivered into suitable receptacles. As the air rises from the hoppers it passes into a number of open-woven canvas sleeves, and escapes through the interstices of the fabric into the room in a filtered condition. By means of a mechanical arrangement, the light dust or fluff that may have been carried up by the air is shaken by the sleeves, and falls by its own gravity back again to the hopper, whence it is conveyed to an outlet along with the heavier dirt.

Waste Shaker.

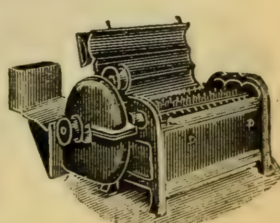


For shaking out the dirt and dust from opener and scutcher droppings, preparatory to their treatment in subsequent operations. Consists of a cylindrical cage or sieve, in which the material is placed. As the cage rotates, the material is rolled about until all the loose dirt therefrom is deposited through the spaces between the wires of the cage. Little power is required to drive the machine.

Thread Extractors.

For extracting the threads from cardroom and spinning room sweepings, roller laps, etc., leaving the "soft" waste in the best condition for subsequent use.

Type 1.—The roller laps or sweepings are placed on the tray attached to the cover of the machine, and should there be found among the sweepings any small pieces of iron, etc., they can be picked out. The waste is then passed through a funnel at the right-hand side of the machine, directly over one of the three spiked rollers, which revolve at a high speed and thoroughly loosen the material, so that the "soft" is separated from the "thread" waste. The portion comprising the "soft" is drawn by an exhaust fan, and is delivered by means of a trunk fitted with a hood which deflects the waste on to the floor; the "thread" portion is retained by the spiked rollers. At intervals the cover is lifted, and the threads found wrapped round the spiked rollers are re-

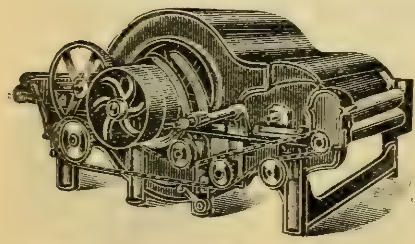


moved by a special form of knife, which is drawn by the attendant along a groove in each roller. After the threads are removed (which takes only a few minutes) the top cover is closed and the machine is again ready to be fed with material. A grid placed underneath the spiked rollers allows the dirt to fall through. The machine is shewn fitted with a cage delivery arrangement whereby the material is caused to pass between a pair of open wire cages, which allow the air to escape and the material to fall down an inclined plate, under which a box may be placed to receive it.

Type 2.—For picking the hard ends or threads from the clearer or "crow" waste made on mules or ring frames. It deals only with American and short-fibred cottons. The mechanism for extracting the threads consists of a shaft, chased from end to end and formed with four longitudinal grooves for stripping purposes. The shaft revolves directly over two beaters, which remove therefrom the loose cotton, while the shaft retains the threads. The material is fed into a hopper, and is carried round by rotary motion given to a feed cone, until it encounters two vertical racks fitted with prongs. These latter work alternately in a vertical direction, and press the waste into the machine. As the loosened material leaves the beaters it is passed through a condensing apparatus, and is delivered in an open condition upon the floor. This machine may be fed automatically or by hand.

Preparing Machine for Hard Waste.

For loosening and combing such hard waste as cop bottoms, ring frame waste, winders' waste, foreign bale waste, etc., preparatory to its being treated by a breaking-up machine. May also be used with advantage instead of the willowing machine for lengthy thread waste.



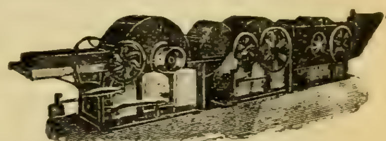
The machine is provided with a large iron cylinder covered with lags, in which are inserted strong steel teeth; an iron doffer also fitted with steel teeth; and a pair of toothed feed-rollers. The material to be opened is fed by hand on to a lattice creeper, and after passing between the feed-rollers is drawn away by the teeth of

the cylinder. The waste is then taken from the cylinder by the teeth of the doffer, which in turn disposes of it to a pair of fluted calender rollers, whence it is discharged in an open condition upon the floor, ready for the breaking-up machine. This machine is sometimes fitted with a lap-forming apparatus.

This preparing machine may also be used in the "engine-cleaning" waste trade. The waste (white or coloured) is first put through the machine and delivered loosely on the floor, after which it is put into a mixing for finishing on an ordinary cleaning waste machine. In this capacity it is known as a "Running-down" Machine.

Breaking-up Machine.

For opening various kinds of cotton waste, cop bottoms, rags, hosiery clippings; also for preparing cotton waste for gun cotton. Is constructed with from one to eight cylinders, according to quantity of production and class of waste. Each cylinder is fitted with spiked teeth. After leaving the cylinder, the cotton is thrown upon revolving cages, formed of cross-woven wire. As the cotton leaves each cylinder, the cage conveys the material to the nip of the next pair of feed-rollers, and thence to the succeeding cylinder for the operation to be repeated. The cotton to be opened is distributed loosely upon a lattice creeper, and delivered to the cylinder by passing between a pair of weighted and fluted feed-rollers.



Grinding Cylinder Teeth.—An appliance for this purpose works on the return traverse principle, and is operated by means of a block working in an endless-screw motion, imparted thereto by belting from a part of the machine. The apparatus is portable, and can be readily removed from one cylinder to another, and be fixed in position on the machine framing.

'Fearnought.'

For mixing or blending and cleaning various qualities of waste. Is well adapted for opening comber waste from a matted condition without damaging the staple.

The cylinder employed is covered with hardwood lags, fitted with forged "cock-heel" teeth. There are seven rollers fitted with "cock-heel" teeth, which work over the cylinder, and are driven from a large spur-wheel on

the cylinder shaft. There is a fan or winged doffer for stripping the cylinder, and the machine is fitted with a cage and delivery lattice.

Pickering Machine.

For dealing with soft waste after it has been made into a mixing. This machine mixes it further, and combs out the fibres, thus preparing it for the subsequent scutching operation. The cylinder of this machine consists of a shell of hardwood lags fitted with forged steel teeth. There is a lattice feeder, and a special mechanism for reversing the feed-rollers and lattice creeper.

Scutcher.

For cleaning the cotton and forming it into laps of uniform weight and density, ready for putting-up at the breaker carding engine. The machine contains one beater only, and is fitted with a lap-forming apparatus. The waste is fed to the machine by a hopper feeder, and the supply is controlled by a cone feed-regulator. This scutcher is required only in large installations; in small plants, or where coloured waste or material of low quality is dealt with, it may be discarded—in which case the breaker card is fed by a hopper of the "Blamire" type.

Vertical Opener.

For use in place of the scutcher in cleaning Indian, Chinese, and other short-staple cottons.

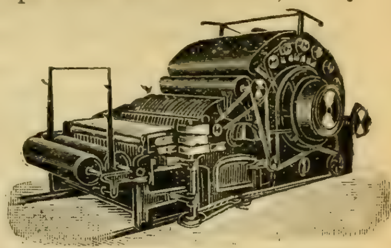
Automatic Feeder.

For use in small installations in feeding breaker carding engines, when it is not desirable to feed by scutcher laps. The hopper of the feeder is kept supplied with loose material by the attendant, who puts in a quantity at intervals of time; it is carried upwards by means of an inclined spiked lattice, and is then stripped by a comb and falls into a scale pan. After the required weight has been deposited, the inclined lattice stops, the scale opens automatically at regular intervals, and the material falls on the travelling lattice of the carding engine and is spread evenly to give a regular feed.

Carding Engine and Breaker.

For dealing with comber waste, broken-up cop bottoms, and other kinds of hard waste. The machine is on the roller-and-clearer principle, and usually contains a 50-inch card-covered cylinder, a 25-inch doffer, and a 9-inch taker-in. There are usually seven rollers and five

clearers, with a "fancy" roller working over the doffer. The machine may be fed by laps from the scutcher, or by an automatic feeding machine, according to the system adopted.



Carding Engine (Finisher).

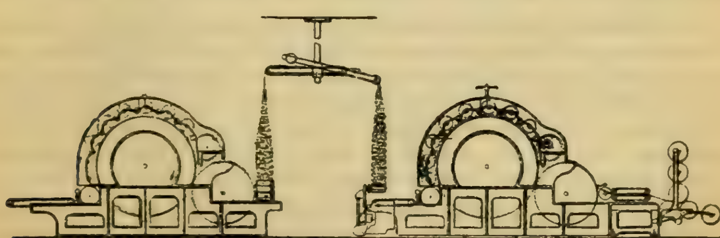
To perform a second carding operation on the waste and prepare it for the subsequent process of spinning. Is practically the same as the Breaker Card, except that it is provided at the delivery end with a condensing apparatus. The machine may be fed by laps from a Derby doubler, or by a Scotch feeder.

Derby Doubler.

For forming the slivers taken from the Breaker Carding Engine into laps for the Finisher Carding Engine. Is usually arranged to make laps about 23 in. wide, and is provided with a V-shaped feed-table for 60 sliver cans. To each sliver or can there is a motion for stopping the machine when a sliver breaks. The cans from the breaker card are placed on either side of the V-shaped table, and the slivers from the cans are drawn through the machine and formed into laps of a given length.

Scotch Feeder.

For use instead of the Derby Doubler. It is placed between the breaker and finisher carding engine, which



latter may be arranged side by side or tandem. It is usually provided with a sliver conductor and an overhead creeper, having a balancing arrangement for the traverse of the sliver. The feed-rollers used are covered with wire filleting.

Condensers.

For dividing up the carded fleece into a suitable number of ends or slivers, varying according to the counts required, and winding the same upon long flanged bobbins. There are two distinct types, known as "Leather Tape" and "Ring Doffer" condensers respectively.

Leather Tape Condenser.—The web of cotton from the doffer is stripped by the doffing comb in a wide sheet, which enters the condenser proper. By means of travelling leather tapes in conjunction with rollers, the web is split into slivers, which are then conveyed either upwards or downwards over rollers to the top or bottom pair of rubbing leathers, thence on to the condenser bobbins—two, three, or four, according to the number of threads and the gauge of the machine upon which the threads are spun.

Ring Doffer Condenser.—In this system the doffer is clothed with card rings, the slivers from which are kept separate by means of leather dividing rings $\frac{1}{4}$-in. wide. The counts of yarn regulate the number of rings, which range from about 14 rings for No. 1's to 30 rings for No. 4's. After being doffed, the slivers are carried forward by means of a grooved dividing roller to a pair of endless rubbing leathers, which by the combined action of crossways and forward movements, roll or condense the slivers into threads. This type of condenser is specially recommended for the better qualities of yarn.

Condenser Card Attachment.—Ensures the two outer or selvedge slivers of cotton being the same thickness as the inner ones, by dividing the usual number of rings on the doffer into spaces of equal width, instead of having the two outer ones wider. The space thus gained is utilised by adding a narrow ring at each side, to take off the defective edge of the fleece. Opposite each additional ring is placed a vertical tube, open at the top, but connected at the lower end to a main pipe running along the floor. This pipe is coupled to an apparatus that by means of a fan draws the edges away, and forms them into a fleece suitable for mixing with the bulk of the cotton already broken up but not carded. By extending the main pipe, and introducing more branches, one apparatus can be made to serve several machines.

Roller Traversing Motion.—To impart a blending action to the cotton as it passes through the Condenser Carding Engine, so as to intermix the irregular weights of slivers taken from the Derby Doubler.

Consists in the application of a side-traversing motion to the feed-roller and to the worker-rollers. The former has a 3-inch sliding movement endways, of 6 per minute, as the feed-roller revolves. The worker-rollers are caused to traverse two $\frac{3}{4}$-inch movements at each revolution, but are operated to move alternately, that is, in a direction opposite to the next worker-roller. The movement is obtained by a two-throw cam motion.

Automatic Oiler for Condenser Leathers.—Consists of a series of covered troughs having oil grooves at the bottom to direct or guide the oil to the inside of the rubbers. There is one groove to each oil-hole; each groove is fed by its own tube from a chamber at the side, which provides the main supply of oil to the pipes collectively. All the connections and tubes are enclosed to prevent dust, and fine gauge wire netting is provided through which the oil is strained or filtered before it is allowed to flow into the respective tubes.

SINGLE FINISHER CARDING ENGINE,

WITH COILING AND CAN MOTION.

For use in the "coiler" or "preparation" system, wherein the broken-up hard waste is to be made into yarn in which strength rather than evenness is of importance, and in the production of counts above 8's or 10's.

The machine has a 50-inch cylinder and a 25-inch doffer. The taker-in is 9 inches in diameter, and there are seven rollers and seven clearers, with one fancy roller. The machine is arranged to take in two half-width or one full-width Derby Doubler laps and to deliver the carded material into four cans fitted with coiling motions.

Slubbing Frame.

For use in preparations worked on the coiler system in spinning from hard waste.

The cans from the Single Finisher Carding Engine are put up at the back of the frame, and by means of drawing rollers and flyer spindles the slivers are drawn out and twisted into rove of a count suitable for the spinning machine. The bobbins from this machine take the place of the long-flanged bobbin in the condenser system.

SPINNING.

In spinning waste fibres the systems adopted are both intermittent and continuous, as in ordinary cotton-spinning; but the principles of each differ—in some cases considerably—as regards the methods of drafting, etc.

INTERMITTENT SPINNING.

The Condenser Mule.—For producing a full soft-spun and level yarn from all kinds of hard waste, comber waste, and soft waste generally.

The condenser bobbins from the finisher carding engine are placed on inclined stands, and are unwound by contact with revolving drums having grooved surfaces. The rove or condenser sliver is delivered from the rollers at a uniform speed throughout the draw, and the speed of the carriage also is uniform. The draft required is effected by the gain of the carriage on the rollers. In the working of this mule there are two spindle-speeds. The first of these is slow and comes into action at the beginning of the draw, and is continued until about two-thirds of the outward run of the carriage has taken place. At this stage the second or greatly accelerated speed comes into operation, and continues during the remainder of the outward movement. The carriage is then reversed and the spun yarn is wound upon the spindles in the usual manner.

Three-Speed Arrangement.—For use when spinning counts above 4's, to ensure that the yarn produced shall be uniform both in strength and thickness. The speeds can be varied at will, and also the time of alteration. The spindles start on the first or slowest speed; after the carriage has run out for (say) about one-third of its draw, the second speed begins, which consolidates the yarn more rapidly; this gives place to the third speed, when the carriage has run out (say) two-thirds, and this extra speed soon puts in the full complement of twist; it is not affected by the speed of the carriage or rollers.

Carriage-Retarding Motion.—For preventing "cut" or thin places in the yarn, which sometimes are made at the commencement of the draw. Consists in an arrangement whereby the delivery rollers are caused to start slightly in advance of the commencement of the carriage in making its outward journey.

Mule for Coiler System.—Is the kind of spinning mule used in ordinary cotton spinning, but of wider spindle

gauge, to suit large cops. The bobbins containing the rove are put up at the creel in the usual manner, and the draft is obtained through the nip of three rows of top and bottom rollers. Is suitable for spinning yarn in which *strength* is of first importance.

CONTINUOUS SPINNING.

In continuous spinning there are several systems available, of which the following are in regular use :—

Ring System.—Similar in general design to the system used in ordinary cotton spinning, but with a few modifications. Is mostly used in spinning hard-twisted thread.

Ring Frame for Soft Yarns.—For use in place of the Condenser Mule in spinning from condenser bobbins. Consists in rearranging the draft rollers and introducing therein additional ones of smaller diameter. These admit of closer setting for the short fibres, but do not sever the long ones. There are two front top rollers, one of which is mounted slightly forward to present the correct angle for the spinning, while the other, along with the third top roller, does the drafting for the short fibres. The drafting for the long fibres is effected between the second and fourth pairs of rollers. The top roller of the third pair is lightly weighted, so as to allow the long fibres to be drawn through without injury; and in order to ensure regularity in the drafting of both classes of fibre the third top roller is fluted. The surface speeds of the third and fourth pairs of rollers are the same.

Tube Frame.—Takes the rove from condenser bobbins, whence it is passed between nip rollers to vertical twisting tubes driven by separate banding from a tin drum on the driving shaft. These tubes impart a false twist to the rove, and prepare it for the drafting process. The tubes are provided at their lower extremities with delivery jaws, which guide the rove into the nip of drafting rollers. Having imparted the necessary draft to the rove, the spinning operation takes place as in an ordinary ring frame.

Cup Frame.—Is well adapted for spinning soft weft of low counts, for use in the weaving of cotton blankets, cleaning cloths, etc. This frame is provided with sheet-metal surface drums, to receive the condenser bobbins, which usually contain 14, 15, or 16 threads each, depending upon the width of the condenser carding engine. Spindle distance is $3\frac{1}{8}$ in. or $3\frac{1}{2}$ in. The cop is built in a

taper cup with an inner spindle on the lines of a pirn winder. As the thread is wound on to the cop it forces the spindle and the cop upwards, until the full length is attained; the spindle is then lifted out of the cup and the cop taken off the spindle. The cup and spindle revolve at different speeds. The thread from the delivery roller passes through the curl in one of the legs of the flyer, and then through a slot in the cup, thus obtaining the required amount of twist. The flyer has a vertical in addition to a rotary motion. The difference in the speeds of the cup and flyer causes the winding-on to take place; the tension is so little that slightly twisted threads may be easily wound.

Special Roving Frame.

For spinning soft waste direct from the condenser bobbins taken from the carding engine. The yarns are used as weft in the production of sponge or cleaning cloth; and as mop and wick yarns.

The frame is designed on the flyer principle, with a suitable creel for the condenser bobbins. There is one line of bottom rollers (fluted), and one line of plain solid top rollers.

When the weft produced on this machine is to be used in the loom single, it is rewound upon close cops for the shuttle, and if in two- or three-fold it is first twisted on a doubling frame, prior to winding.

TREATMENT OF WASTE FOR MAKING INTO YARN

To be used in the Manufacture of Sheetings, Flannelettes, etc.

There are two classes of waste used for this purpose, which are known respectively as "Hard" and "Soft." The methods of their treatment differ according to the use to which the waste is put.

Hard Waste consists essentially of the waste from ring frames and reeling and winding machines, cop bottoms, and all other waste of a thready nature. The product is invariably spun into the finer counts of yarn.

Soft Waste is mostly composed of scutcher droppings, card cylinder and flat strips and fly, clearer laps, sweepings, etc. It is adapted for lower counts, soft-spun weft, etc. In order to obtain the best results from the above waste it is essential that the two kinds be separated as much as possible and treated accordingly.

The machinery in the opening, preparing, and spinning of waste consists of two recognised systems:—(1) The "Condenser," which is a modification of the woollen system; and (2) the "Coiler" or "Preparation," which is an arrangement somewhat similar to that adopted in the treatment of ordinary cotton. On either system, the yarn produced possesses a distinctive character.

The **Condenser** system gives the best results where a full, level, and soft yarn is required, such as that required for weft in the weaving of flannelettes, sheetings, etc. The system also lends itself to the treatment of both hard and soft waste, which may be mixed or treated separately.

The **Coiler** system is most suitable where strength is of most importance, and where the counts spun are higher than 10's. It may be adopted for the production of both hard and soft waste as weft in the weaving of cloths to be dyed or printed, such as cretonnes, towels, etc. The product may also be bundled into hanks and used in the making of ropes and twines. It is less costly than the Condenser system, and can be adopted for a wider range of counts.

INSTALLATIONS from which good results can be obtained:—

(I.) For spinning counts of (say) 5's to 10's from "hard" waste, including cop bottoms, on the condenser system, to produce a soft, full, and level yarn:—

- Opening and Willowing Machine.
- Breaking-up Machine with soaping apparatus.
- Single Beater Scutcher, with hopper feeder and lap-forming apparatus.
- Single Breaker Carding Engine, fitted with single sliver can and coiling motion.
- Derby Doubler, for making laps for the finishing carding engine.
- Single-Finisher Carding Engine, with condenser on the ring doffer principle.
- Self-acting mule, to take in condenser bobbins.
- Grinding Machine and Rollers.

(II.) For spinning counts (say) Nos. 3's to 16's, from "hard" waste, including cop bottoms, on the "Coiler" or "Preparation" systems, to produce a strong yarn:—

- Opening and Willowing Machine.
- Breaking-up Machine, with soaping apparatus.
- Single Scutcher, with hopper feeder and lap-forming apparatus.

Single Breaker Carding Engine, fitted with single sliver can and coiling motion.
Derby Doubler, to make laps for the finisher carding engine.
Single Finisher Carding Engine, with sliver coiling and can motion; four cans.
Slubbing Frame, to prepare the rove from the slivers contained in above cans.
Self-acting Mule, to take in bobbins from the above frame. Or—
Continuous Spinning Frame, on the ring or other system available.

For spinning counts (say) 1's to 5's, from "soft" waste, including scutcher droppings, card fly, and flat strips, clearer laps, sweepings, etc., on the "condenser" system, to give a level and full yarn:—

Willowing Machine, with lattice-feeder and overhead delivery apparatus.

Thread Extractor, with fan and cage delivery.

Pickering Machine, single cylinder.

Single Scutcher, with hopper feeder and lap-forming apparatus.

Note.—In small plants, or where coloured or lowest quality of waste is used, this scutcher may be dispensed with, and the breaker carding engines receive the supply of cotton through an automatic feeding machine of the "Blamire" type.

Single Breaker Carding Engine, connected by Scotch Feeder to a

Single Finisher Carding Engine fitted with a

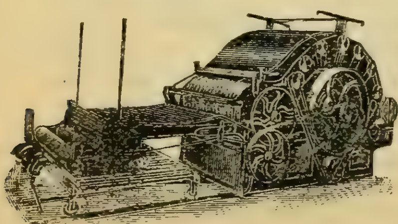
Ring Doffer Condenser or a

Leather Tape Condenser.

Self-acting Mule, to take in condenser bobbins; or a
Continuous Spinning Frame; *or* Special Roving Frame for counts up to 4's, hard twisted, suitable for sponge cloth weft, mop, or wick yarns.

COTTON WADDING.

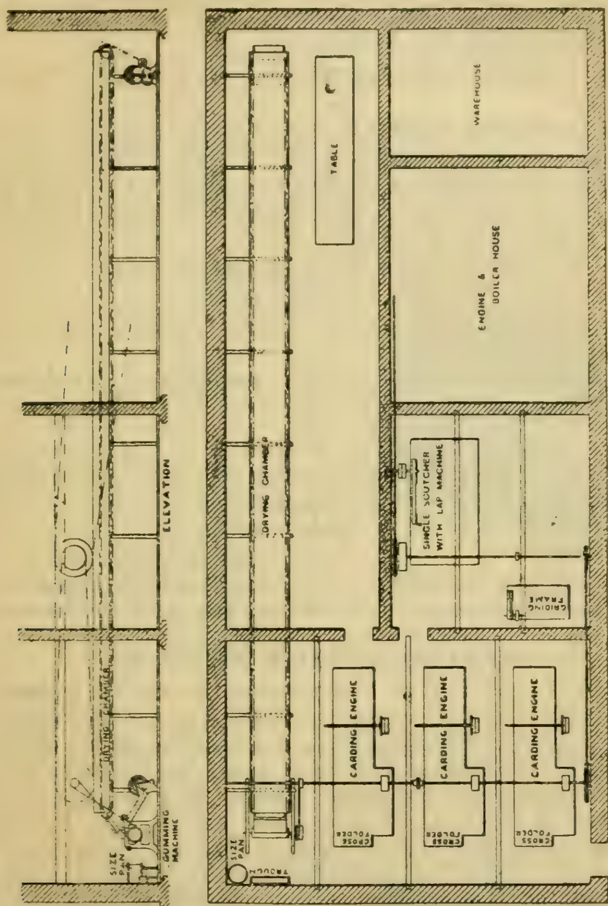
Loose cotton waste in its clean and open condition may be used as ordinary wadding for domestic purposes, as surgical wadding, and in the preparation of the compounds of cellulose and artificial silk, etc.



ORDINARY WADDING.

After the raw material has been opened and cleaned, it may be manufactured into wadding by either of two systems, namely—the "Long" system or the "Short."

Long System.—This is applicable when the material to be dealt with is in sufficient quantities to keep employed a full set of thirteen carding engines. This system also enables the manufacturer to produce wadding having



COMPLETE INSTALLATION FOR THE MANUFACTURE OF WADDING.

an outer surface of a better material than the interior of the fabric; generally the product is uniform.

Short System.—A fleece of wadding is made separately and completely on one carding engine. This system facilitates the manufacturing of varying qualities and quantities of wadding, to suit circumstances.

Long System.

Thirteen Carding Engines, fed either by hand or lap, and provided with lattice for delivering to a travelling chain-creeper.

One Travelling Chain Creeper, with laths 40 in. wide, for accumulating the fleece.

One Lap-Forming Apparatus, for making the fleece into laps.

One Gumming Machine, with diagonal feeding lattice, gumming roller, and gum or size supply cistern.

One Boiling Pan for the gum or size, 30 in. dia. × 26 in. deep, which must be double-cased and made to stand a steam pressure of 60 to 70 lb.

One Metallic Creeper, to work overhead and carry the sized wadding through a drying chest.

One Drying Chest, usually of wood, 100 ft. long × about 20 in. deep inside.

One Lap-Forming Apparatus, for lapping the wadding after it is gummed and dried.

Short System.

Thirteen Carding Engines, fed either by hand or lap, and each provided with a cross-folding apparatus to make folds from 18 in. to 40 in. wide. Also—

1 Boiling Pan.	1 Drying Chest.
1 Gumming Machine.	1 Lap-forming Apparatus.
1 Metallic Creeper.	[All as in the "Long" System.

SURGICAL COTTON WADDING.

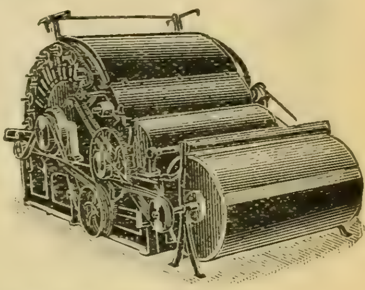
Surgical wadding or "absorbent cotton" is invariably made from a grade of cotton waste known as "linters," which consists of short fibres, the residue of the ginning process of separating the seed from the cotton. Owing to the material having been packed in bales for transit, it arrives at the mill in a more or less matted condition. It is therefore first put through a Willow, which machine loosens the fibres and removes a great proportion of the shell and chip therefrom, thus preparing it for subsequent treatment.

Cotton intended for surgical purposes requires to be most thoroughly purified by an energetic course of bleaching. The first step in this process is boiling under pressure, in a comparatively strong solution of caustic soda with the addition of a solvent of non-saponifiable mineral

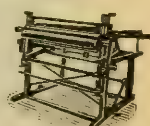
oils. Washing follows. Then : Souring with dilute hydrochloric acid. Washing. Chemicking with hypochlorite of soda. Washing. Souring and blueing. Drying and carding.

After undergoing the treatment thus outlined, the material still remains in a more or less matted condition; and in order to prepare it for the carding it is first passed through a **Pickering Machine,** of the kind used in soft waste spinning.

The **Carding Engine** (in which it is next treated) is the roller-and-clearer type, with certain modifications to suit the short-stapled cotton. The machine works the cotton into a very thin web or fleece, fibres all parallel, and at the same time any shell or foreign matter is removed. The carded material leaves the machine in this thin web or fleece, and in order to obtain the required thickness it is necessary for numerous layers of the fleece to be added together. This is effected by means of a wooden fleece drum at the front of the carding engine; as the web is stripped from the latter it is wound round the drum, and layer on layer is added until the desired thickness is obtained. The web is then cut across and removed from the drum in a sheet 7 ft. 6 in. long, and about 40 in. or 48 in. wide, according to the width of the carding engine.

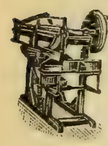


For convenience in its handling, the material is put up in the form of a roll, usually with a sheet of paper inserted and rolled along with it. To accomplish this a **Wadding Roller** or **Winding Machine** is used. The sheet of absorbent cotton is laid on the table of the machine, the sides of which are adjustable to suit various widths of material. It is then passed between a pair of iron calender rollers to a lap rod; the latter is made in two halves, between which the edge of the wadding is inserted. By turning the handle attached to the lap rod, the roll is wound between two iron winding rollers and an iron compression roller. As the roll becomes larger in diameter, the compression roller lifts vertically, main-



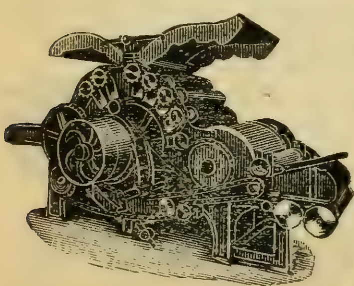
taining a constant pressure, thus ensuring even rolling and preventing distortion of the sheets. The paper insertion is fed from a roll placed under the machine; and when the required diameter of the roll is obtained, the paper is cut by a knife operated by a lever, and the roll is then ready to be removed from the lap rod. By the use of this machine, rolls can be made of various diameters up to 6 inches.

The final operation is that of cutting the rolls into suitable lengths for retailing by the shops, 12 inches being the usual length. For this purpose a **Roll Cutting Machine** is used. The roll to be cut is placed in a sheet-metal support or holder, by which it is firmly held while being cut by a reciprocating horizontal knife, the holder being slotted to give access to the knife blade. As the roll is being cut, the support or holder carrying it is lifted vertically by means of a lever and weight, which can be readily adjusted to maintain the required pressure against the knife blade. An adjustable measuring scale is provided to enable repetition rolls of equal length to be cut. For various diameters of rolls an additional holder is required, which may be any size from $1\frac{1}{4}$ inches to 6 inches diameter. This machine can also be arranged to cut surgical bandages into narrow widths from the roll of cloth.



ENGINE CLEANING WASTE.

Is invariably made from very hard-spun waste, or such as contains a large quantity of foreign matter. After the material has been bleached and dried, it is subjected to a thorough combing and loosening process to render it suitable for wiping or cleaning purposes.



The machine employed resembles the ordinary roller-and-clearer Card, but is much more strongly built. The cylinder is covered with hardened steel teeth two inches deep. The doffer is made up of iron lags, into which are set steel staple teeth. There are usually three workers, in which are inserted what are known as "cock-spur" steel teeth, arranged in rows equidistant from one another, each row being set so that the spaces between

the teeth alternate. The strippers (of which there are four) are covered with steel fillets. The feed-rollers are made up of iron segments, having the teeth cast in. The feeding lattice consists of a series of iron segments held together by leather belts, and at the delivery end is a pair of calender rollers.

ROVING WASTE.

Although of good quality, this waste has undergone a slight twisting, and is therefore not in a fit condition for mixing with that from the card and draw frames. Nevertheless, it is much too good to go with spinning-room waste. If the waste be passed through one of the mill scutchers along with the opened cotton, the twisted portions are liable to make their appearance in the subsequent processes on account of their stringy condition. The best result is obtained by employing a **Roving Waste Opener,** which is a special machine designed for the purpose. A full description of this machine is given on pp. 50 and 51.

FLAT STRIPS.

By using a special series of machines, something like 50 per cent. of good cotton may be recovered from the card strips made in a mill spinning American cotton. These machines comprise :—

Combined Opener and Scutcher.
Revolving Flat Carding Engine.
Drawing Frame with 1 head only.
Sliver Lap Machine.
Comber worked on the "Nasmith" or "Whitin" principles.

The good cotton from the comber is taken in the form of sliver and put up at the finishing heads of the ordinary draw frames, in the proportion of 1 to 5 in a frame of six ends up.

ABSORBENT COTTON OR SURGICAL LINT.

Absorbent cotton has in recent years been used otherwise than for medical purposes, and is now in requisition industrially for the preparation of compounds of cellulose and artificial silk. The purification of cotton, both for medical purposes and for the special products named, is as important a feature of its course of treatment as is that of rendering it hydrophile in character. As far as cotton for medical purposes is concerned, it has to be remembered that the impurities natural to cotton consist

of organic matters, which offer much less resistance to various reagents and are much more susceptible of giving rise to fermentation products, and in consequence more prone to putrefy, than cellulose, which is characterised by negative chemical properties. Therefore the degree of purity of cellulose measures the degree of aseptic power of absorbent cotton and is the essential condition of its hygienic character.

Determination of Cellulose.—Some recent work, designed with the object of finding the most suitable means for determining the percentage of normal cellulose in surgical cotton or similar materials, seems to suggest that Lange's method (potassium hydroxide at a high temperature) requires modification. The method as originally described is, however, defective, owing to the continuous concentration of the alkali, and this may be remedied by working under a reflex condenser. The modified method suggested is as follows:—0.5-2.0 grms. of the air-dry material (surgical cotton) is placed in a 500 c.c. Jena flask with round bottom, with 50 c.c. of potassium hydroxide solution; the flask is connected with a reflex condenser and heated in a paraffin bath at 130 to 140 deg. C. At the end of the time found to be necessary for the treatment, the flask is allowed to cool to 70 to 80 deg. C., and the contents are washed out into a beaker. The residue of cellulose is collected in a Gooch crucible, washed, acidified, again washed with dilute alkali, water, alcohol, and ether, then dried to constant weight.

The main difficulty is due to serious bumping, which may be mitigated first by weighing out the sample in a compact mass, and secondly by passing a long glass rod down the condenser, so that its end rests on the sample of cotton, holding it down at the centre of the bottom of the flask. The reaction is characterised by a definite constant limit, beyond which further treatment even for several hours produces no appreciable effect on the results. Hence it is presumed to effect a sharp separation of the modified or non-cellulose constituents of the sample from the true normal cellulose. The time required to reach this limit depends on the concentration of the alkali, and is longer with higher concentrations. Thus, with 20 per cent. potash lye a constant yield was reached only after 15 hours' boiling, with 10 per cent. the same point was reached after six hours. With the type of cotton employed, the yield of normal cellulose

obtained was about 92.5 per cent. on the sample containing 3.3 per cent. of moisture. Cellulose reprecipitated from cupric-ammonium solution and oxycellulose gave indefinite and low results, shewing that these substances behave very differently from the original cotton.

Preparation.—The preparation of absorbent cotton is simple enough when there is only from 5 to 6 per cent. of impurities to remove; but in the boiling and bleaching operations there is risk in introducing other impurities, besides interfering with the strength of the fibre.

Bleaching.

The bleaching of cotton intended for surgical purposes, and for the manufacture of artificial silk and of nitro-cellulose, presents certain special features.

For these purposes the cotton requires to be most thoroughly purified by an energetic course of bleaching. As the material forming the basis for the production of pure nitro-cellulose, absorbent, hydrophile, or surgical cotton wadding, consists mainly of cotton waste, and sometimes of oily waste, the impurities to be removed are numerous. Some manufacturers consider that it is really immaterial whether the course of bleaching causes the conversion of some portion of the cellulose into oxycellulose and hydrocellulose; and in these circumstances the action of the active agents in the bleaching of the cotton may be pushed to a greater extent than when the production of pure cellulose alone is the objective. The latter object, however, is the better of the two, for it certainly gives rise to less loss in weight during the drying and carding operations following the bleaching, and a pure cellulose is the real requirement for the production of nitro-cellulose (gun-cotton), as also for the manufacture of artificial silks, and it should be for the making of surgical waddings.

The course of treatment varies somewhat. In general it consists in removing, by the mechanical means known as "willowing," of as much as possible of the dirt present. (Oily waste is extracted beforehand with benzene.) The next step is boiling under pressure, with a comparatively strong solution of caustic soda along with an addition of a solvent of non-saponifiable mineral oils. Washing follows. Then: Souring with dilute hydrochloric acid. Washing. Chemicking with hypochlorite of soda. Washing. Souring and blueing. Drying. Carding.

The **boiling kier** is provided with a perforated false bottom and cover between which the material is held in position during the boiling. The liquor—3 to 4 per cent. caustic soda and a quantity of ethylene perchloride (controlled by the proportion of mineral oils present in the cotton)—is prepared beforehand in a separate vessel, and admitted into the kier from the lower part by the creation of a partial vacuum within the kier. This is done to secure a quick wetting-out of the material, and to avoid the felting and the matting of the fibres that would take place if the cotton were placed in liquor already in the kier. When felting and matting is allowed to take place, it increases the subsequent work of carding, and with it the fibres become torn. Such a compact mass of cotton, held tightly by the false bottom and cover, calls for a strong and regular circulation of the lye. To avoid the clogging of the pipes by loose fibres and tufts of the cotton, thickly-woven cotton cloths are laid over the false bottom and under the false cover. And to avoid the deposition of rust and other impurities on the cotton by the steam, injectors and open pipes for heating and causing the circulation of the liquor are not generally employed, but instead superheaters and centrifugal pumps. Boiling is continued for about seven hours at a pressure of four atmospheres.

Next, the cotton is washed well in the kier, and afterwards removed and placed in a wooden vessel provided also with a false bottom and cover, and connected with a centrifugal pump. Here the cotton is treated with a 1 per cent. solution of hydrochloric acid, kept in constant circulation for one or two hours; washed well, and treated with a weak solution of hypochlorite of soda in circulation for three or four hours. It is again washed, soured slightly, washed, and finally washed in the hollander machine with a plentiful supply of water.

The resulting bleached and pure cellulose—if intended for surgical wadding—is generally blued slightly before the drying and carding, and in some instances is steamed to sterilise it.

The material is treated very frequently also to give it the silk-like scroop so much in favour. This is accomplished by treating with a 3 per cent. solution of a good neutral soap and subsequently souring with acetic acid, tartaric acid, or even sulphuric acid, whereby the fatty acid is liberated from the soap. In the last acid liquor it is customary to tint the cotton intended for surgical

purposes with a suitable blue colouring matter. In view, however, of the undoubted desirability of attaining the highest possible degree of purity, the practice of blueing and of scrooping should really be deprecated.

When the bleached product is for the manufacture of nitro-cellulose and artificial silk, it is at once dried without soaping or tinting.

Bleaching Plant Required.

Automatic Conveyor from willow to kier.

Iron Tank for preparing lye.

High-pressure Kier, one or two tons capacity.

Two Wooden Cisterns, capacity corresponding to that of kier.

Hollander Washing Machine.

Continuous Air-drying Machine.

Some Points.—There is really no difficulty in meeting the requirements if the process be carried out intelligently and carefully; but some of the methods which have been lately introduced on a large scale are undoubtedly open to criticism. As a consequence, the quality of different makes of absorbent cottons varies very much, and, apart from the consideration of the degree of the white, complaints are made that some makes contain appreciable amounts of fatty substances and of free sulphuric acid. These are present mainly because of the attempt to meet the popular demand for a silk-like scroop on absorbent cottons. It certainly appears somewhat strange—in view of the fact that the initial object of the bleaching operations is really one of freeing the cotton of its impurities, fatty substances, included—that acid and soap should be added to it afterwards. This, however, is sometimes done to attain the "scroop." The presence of an undue amount of free sulphuric acid is owing to insufficient washing of the material. Absorbent cotton for use by doctors and surgeons should (as stated above) obviously be very pure—in fact, pure cellulose—and this essential acquirement would be more completely fulfilled if users would not prefer the scrooped cottons.

Imperfections in the boiling-out operations may result in only a partial expulsion of the air from the fibres, and this, in spite of all ulterior precautions, causes the introduction of a certain quantity of air into the cellulosic

solutions, the presence of which may often account for the resulting cohesion of fibres of artificial silk. Osmotic phenomena are influenced by different factors which call for consideration. Naturally enough, the rate of penetration of salt solutions through the cell wall of the fibre should be slower than that of pure water; the rate of diffusion depends equally on the density and the viscosity of the solutions employed, so that it seems fair to admit, in extending the law of Graham, that "under the same pressure, liquids pass through the same wall at speeds in inverse ratio to the square root of their density."

Detecting Free Sulphuric Acid.—Zanker and Schnabel observe in the "Farber Zeitung" that it is not always possible to detect the presence of even considerable traces of sulphuric acid in cotton by extraction with boiling distilled water and testing according to Emich's method with litmus silk, although this is more delicate than litmus paper. It is well known in practice that it is impossible to free cotton completely from sulphuric acid, which may even be detected in cotton treated with decinormal sulphuric acid and then rinsed for several weeks in water. By pressing a piece of litmus paper against the half-dried material and comparing its colour with that obtained from a blank experiment, using pure cotton, 0.01 per cent. of sulphuric acid can be detected in cotton, whereas the aqueous extracts do not produce any change in the very delicate litmus silk. Dyed material is tested by moistening with alcohol and ether to about one-third or one-quarter its weight, to prevent the colouring matter also being transferred to the litmus silk.

An instance is mentioned of a sample of cotton wadding for surgical purposes, and stated to be of good quality, which, upon extraction with boiling water, was found to contain 0.08 per cent. of free sulphuric acid, and a total of 0.16 per cent. was found by digesting with centi-normal caustic soda solution. It is considered that such amounts would affect the healing properties of boric lint and affect the usefulness of absorbent cotton.

Bayers' Process.—For treating cottons and textile materials intended for disinfecting and sterilising purposes, Messrs. Bayer und Co. patented some years ago a process of fixing formaldehyde-producing compounds by the help of collodion. Some difficulties were encountered in

properly attaining the fixation of these substances so as to allow of the liberation of the potent formaldehyde at the right time. It has been found, according to a later patent of the same firm, that the desired results can be attained by making use of the properties of barium peroxide, 3 parts of which are mixed with 1 part of paraform and the required amount of collodion. In this way formaldehyde is gradually liberated, and the treated material thus rendered of service for disinfecting and sterilising.

Prescribed Purity

Surgical, or absorbent, cotton made from cotton-waste must present the following characteristics:—When bleached it must be inodorous and tasteless; insoluble in ordinary solvents, but soluble in an ammoniacal solution of cupric oxide. When the bleached absorbent cotton is thrown on the surface of cold water, it should readily absorb the water and sink, and the water should not acquire an acid or an alkaline reaction, which is evidence of proper purification and absence of fatty matter. Absorbent cotton should be perfectly free from all visible impurities, and on combustion should not leave more than 0.3 per cent. of ash.

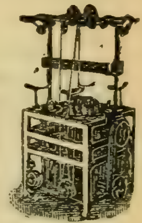
Properly made absorbent cotton should have the property of taking up 18 to 20 times its own weight of water, and the way to determine this is to weigh out exactly 5 parts of the sample (absolutely dry) and immerse it for five minutes in pure water, remove carefully without excessive squeezing, and place in a small weighed funnel and allow to drain under slight pressure, and again weigh. Deducting the weight of the funnel from the combined weight of the funnel and the wet cotton, and dividing by 5, the result will be the amount of water absorbed, in multiples of the original weight of cotton taken.

BLEACHING FOR GUN-COTTON.

For gun-cotton the material most largely employed is a mixture of spinning waste and American "linter-waste." The mass is first torn up and the lint passed through a cleaning machine to remove all mechanical impurities. Oil, natural wax, proteins, etc., are then removed by digesting with about 1 per cent. caustic soda solution under 3 atmospheres pressure. The material must be tightly packed in the boilers and good circulation ensured; high purity of the soda and the exclusion of

air during boiling and washing are advantageous. Bleaching must be very carefully controlled to preserve the chemical integrity of the cellulose; a little acetic acid may be added. The "copper-value" (Schwalbe's test) must not exceed 1.0; fat and waxy matters, extracted by absolute alcohol, 0.5 per cent.; wood-gum, 2 per cent. Tissue paper, from sulphite wood pulp, may also be used for nitrating, but is dearer than cotton-waste, and yields an inferior product.

BANDING, SMALLWARE WEBBING, &c.



In many spinning mills it is customary to make the banding for driving mule and ring frame spindles from the damaged and waste cops produced in the spinning rooms. Two kinds of banding are made for this purpose—tubular, and twisted (or "solid") banding.

Tubular Banding is made in the form of plaited braid with a hollow core, by crossing and recrossing several strands of yarn together (the latter having been previously wound from the cops on to bobbins suitable for the machine). The banding produced on this machine is very durable, and will last about three times as long as "solid" banding.

Twisted or Solid Banding is made by twisting a number of strands of yarn together after the manner of rope or twine. It is produced cheaply, and not so durable as tubular banding.

BANDING MACHINES.

Tubular Banding Machines are constructed with from 1 to 6 heads, each head containing 12 or 16 spindles. Usually driven by belt power. As the banding is made, it is wound upon bobbins or spools and put into stock to be used as required. **Speeds.**—105 revs. per min.

Pulleys.—16 in. dia. × 3 in. wide.

Power.—3 heads equal $\frac{1}{16}$ I.H.P.

Production.—250 yards per head in 10 hours.

Floor Space— 1 head............1 ft. 8 in. by 1 ft. 8 in.
6 heads...........4 ft. 6 in. by 3 ft.

High Speed Tubular Banding Machines.—These machines are entirely self-contained, and are made in three sizes of 8, 16, and 24 spindles respectively.

I.—In which the machine is formed with two circular racks, one of which is stationary while the other revolves at a high speed. The plaiting of the threads is effected by pinions, which gear into the racks and alternately carry the threads over and under each other, as the banding is formed. Stop motions are provided for arresting the machines when a thread breaks.

Speeds.—8 to 16 spindle machine, 300 to 400 revs. per min.; 24 spindle machine, 250 to 300 revs. per min.

Pulleys.—6 in. × $1\frac{1}{2}$ in. and 8 in. × 2 in. respectively.

Power.—$\frac{1}{3}$ I.H.P. and $\frac{1}{2}$ I.H.P. respectively.

Production—

8	spindle machine	......2 to 3 yards per min.
16	ditto	......3 to 4 yards per min.
24	ditto	......2 to 3 yards per min.

II.—In which the carriers for each set of bobbins are supported upon axially-mounted tables or "spiders." The inner carriers are mounted on discs, which have a circumferential lip that enters open-ended grooves in the inner spider, so that the disc-carrier is free to rotate within the spider. The inner bobbin-carriers are thus held and mounted by a portion of their circumference only, leaving the other portion free. Guide-arms, through which the threads pass, are caused to intercept the threads of the inner bobbins at suitable intervals, by guiding the outer threads into slots provided in the discs. This type of machine will make braid of patterns 1 over 1, 2 over 2, 2 over 1, and 3 over 1.

Winder.—For use in conjunction with tubular banding or braiding machines. Is constructed to wind from cops, ring bobbins, or ordinary flanged bobbins, and is provided with mechanism for stopping the machine if any one of the multiplicity of threads put up should break, and a motion to act when the receiving bobbin has attained the required diameter. The machine is also fitted with a tension arrangement, and provision is made for changing the bobbins.

Solid Banding Machines are made with 1, 2, 3, or more heads in one frame, up to 18 heads. Each head works independently, and a stop-motion is provided to each spindle. **Speeds.**—225 revs. per min.

Pulleys.—$8\frac{1}{4}$ in. dia. × 2 in. wide.

Power.—3 heads equal $\frac{1}{4}$ I.H.P.

Production.—1,200 yards per head in 10 hours.

Floor Space—
1 head......3 ft. by 2 ft. 6 in.
6 heads.....8 ft. by 2 ft. 6 in.; to any length.

Band Stretching Machine.—For taking the excessive stretch or elasticity out of spindle bands and similar driving bands before use. Is a power-driven machine, in which the banding is passed round grooved pulleys, and is then taken to a drum or bobbin. The shaft upon which this latter is mounted is driven by spur gearing from the first motion shaft. The extent of stretch is governed by a weighted brake lever.

Smallware Looms.—For weaving tapes, lamp-wicks, hose-piping, and other narrow webbed material. Are mostly power-driven, and embody the principal motions of the calico loom—namely, shedding, picking, and beating-up. Owing to the narrowness of the products the shuttles and shedding motions are duplicated, after the manner of a Coventry loom. They are usually made to take in from 4 to 10 shuttles. When the material woven is complicated, the looms are fitted with jacquard mechanism worked from the outside.

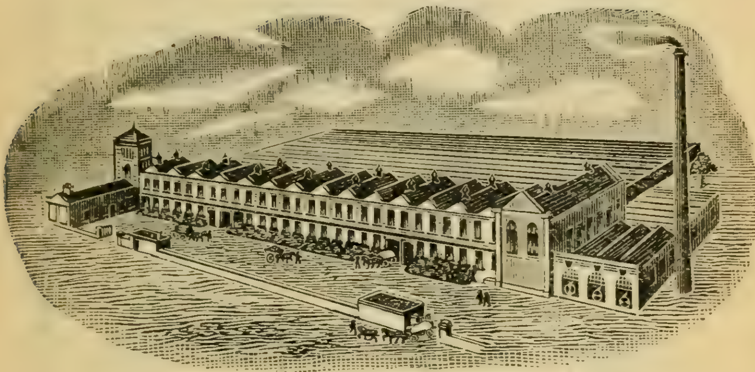
ELASTIC THREAD, WEBBING, &c.

The manufacture of the above includes such articles as plain cords, fancy braids and cords, brace webs, webbing for surgical purposes, etc.—all of which are made from rubber thread covered with yarns of various kinds. The machines employed work on the braiding or plaiting principle, and are usually made up of several heads mounted upon one frame. Each head is capable of laying or twisting the thread round the rubber strand in one or more layers, which may run in one or opposite directions to suit the variety of work to be produced. Each head is driven separately from one line shaft.

In the production of Flat Elastic Braids, the widths are varied by the number and counts of yarn and the sizes and numbers of threads inserted.

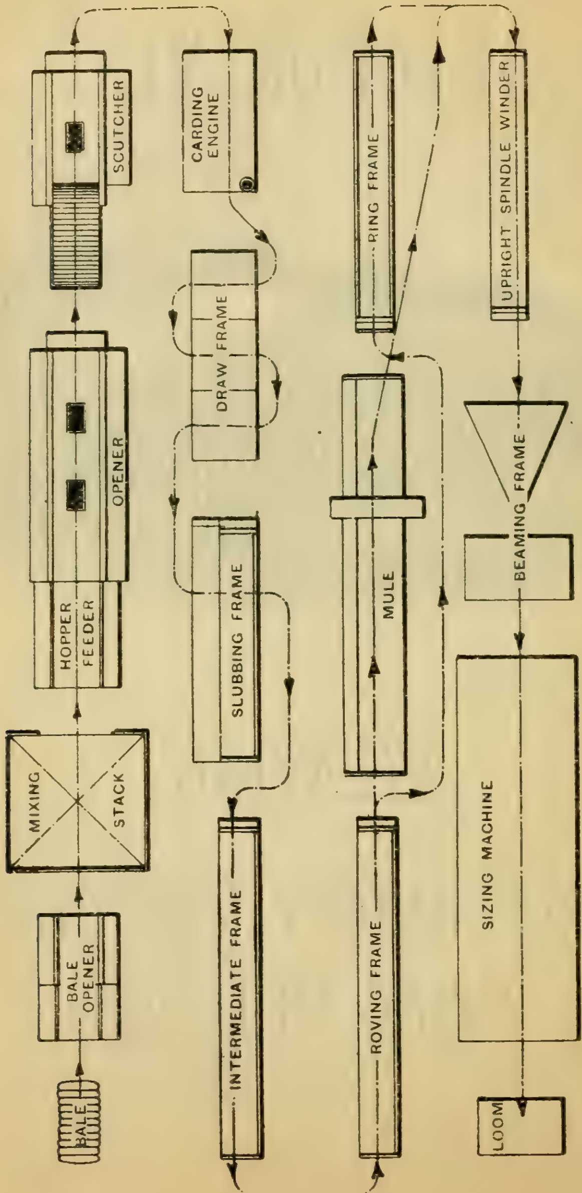
For Brace Webs and similar fabrics, looms are employed which work on much the same lines as those used for the weaving of ordinary tape—the main difference being that a separate arrangement is provided for the rubber thread which is to form part of the warp as the weaving proceeds. These looms are provided with jacquard machines for controlling the patterns in the web.

SECTION VI:



WEAVING

PREPARATORY MACHINES
SIZING METHODS
ETC



SEQUENCE OF MACHINES FOR SPINNING AND WEAVING ORDINARY COTTON PIECE-GOODS.

SUMMARY OF MACHINERY

FOR A WEAVING SHED,

Containing 1,350 Looms, producing Printers' Cloth. Consuming 28,500 lb. of 32's twist and 19,000 lb. weft, in 56 hours.

Nine Upright Spindle Winding Frames, of 300 spindles each. Employing 68 winders, attending to (at the rate of) 40 spindles each.

Eighteen Self-stopping Beaming Machines, each 9/8ths wide, with self-stopping motions and creels for 501 bobbins. Employing 18 operatives, or one to each machine.

Six Slasher Sizing Machines, each 9/8ths wide, with creel for six beams. Employing one attendant to each machine, with the assistance of two labourers.

Six Size Mixing Becks, which are usually in ranges of three, consisting of the following:—

Fermenting Cistern, in which the flour is mixed with water.

Diluting or Storage Cistern.

Mixing Cistern proper, over which is usually fixed a metal pan to receive and mix tallow, china-clay, and other ingredients.

Eighteen Looming Frames and 8 Drawing-in Frames, employing 18 men and four girls to assist them.

Five Plaiting or Folding Machines, employing 10 operators.

Three Hydraulic Cloth Presses, employing one attendant each.

Nine Cloth-inspecting Machines, each requiring one attendant. These machines also measure the cloth as it passes over the tables.

1,350 Looms, employing 386 weavers, at the average rate of 3½ looms per weaver.

Labour.—Fourteen "Jobbers" or "Tacklers," to attend to the looms.

Power.—Three Lancashire Boilers, 30 ft. 0 in. × 8 ft. 0 in.; 298 Economiser Tubes. Engine, 650 I.H.P.

PREPARATORY WEAVING PROCESSES AND MACHINERY

Yarn as delivered by the spinning machines is unsuitable both in form and condition for immediate conversion into cloth. Certain preparatory processes—which vary in their nature and extent, according to the style of yarn and the cloth to be woven—are necessary before it can be placed in the loom. Mule cops are usually delivered directly to the manufacturer, who then undertakes all the processes. Spinners of ring yarn and doublers, however, find it more convenient to empty their frame bobbins into one or other of the following forms: hanks, cheeses, ball and chain warps, or back beams, thus avoiding the trouble and expense of "empties."

In the case of Warp yarn, the preparatory processes have chiefly for their object—(1) The collection of a number of threads sufficient to give the desired width and fineness of cloth. (2) The increase of their strength and smoothness, in order that they may withstand the strain and friction of weaving. (3) The winding of them evenly upon the loom beam in such a manner that each may retain its individuality and occupy a position corresponding with that which it is finally to take up in the cloth. Schemes of warp preparation in ordinary use are as follows (commencing in each case with the material as it leaves the spinning machine):—

For Grey Goods.

SCHEME A.—1. Winding upon warping bobbins.
2. Warping upon back beams for the slasher.
3. Sizing, and beaming upon the loom beam, by the slasher sizing machine.

SCHEME B.—1. Winding upon warping bobbins.
2. Ball or chain warping. 3. Ball sizing.
4. Beaming or winding upon the loom beam.

For Coloured Goods.

SCHEME A.—1. Winding to warping bobbins.
2. Ball or chain warping.
3. Bleaching or dyeing and sizing of the ball or chain.
4. Yorkshire dressing and beaming upon the loom beam.

SCHEME B.—1. Reeling from cop or ring bobbin into hanks.
2. Hank bleaching, or dyeing, and sizing.
3. Winding from hanks to warping bobbins.
4. Sectional warping and beaming.

SCHEME C.—1. Reeling from cop or ring bobbin into hanks.
2. Hank bleaching, or dyeing, and sizing.
3. Winding from hanks to warping bobbins.
4. Beam warping.
5. Re-beaming to the loom beam.

In every case the last-mentioned process is followed either by drawing in or twisting.

Of the systems for Grey Goods, A is the one mostly used, on account of its greater economy of time and material, B being adopted principally by small manufacturers who have not a sufficient number of looms to keep a slasher sizing machine in full work.

Of the schemes for Coloured Goods, A prevails in certain districts, and appears to be more economical when the number of colours in a warp does not exceed three or four. B is predominant in other districts, and is considered by some manufacturers to produce a better beamed warp, and is more economical when many colours are present. C is chiefly used when a number of loom beams are required to be all of the same pattern.

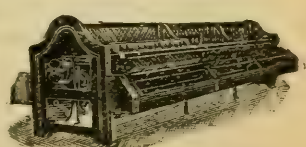
As regards the preparation of Weft Yarn for "grey" cloths, mule pin cops and ring weft bobbins are ready for the shuttle; but larger cops and hank yarns require to be wound upon pirn bobbins, or into cops of convenient size for the shuttle. Mule weft can now be satisfactorily bleached or dyed in the cop form; but the greater amount of waste made when weaving from such cops greatly discounts the saving effected by the omission of the processes of reeling and pirn winding. It is therefore still the general practice to bleach and dye yarns in the hank form, and afterwards wind to pirn bobbins.

WARP WINDERS.

The Vertical Spindle Winder.

Function.—To transfer twist or warp yarn from the mule cop or ring bobbin to warping bobbins, and to eliminate faulty places.

Description.—In the usual type of machine each side has two rows of vertical spindles, which are driven by bands from a central tin drum, and are provided with a disc near the top to carry the bobbin. Cops or ring bobbins are placed upon skewers or pegs, and the thread is passed over a flannel-covered board for tensioning purposes, taken through snick plates, and guided upon the



bobbin by a traversing rail, which is moved up and down by mangle-wheel or heart-cam motions. The speed of the guider rail is usually decreased as it approaches the centre of its lift, and is accelerated from that point on-

wards, in order that a barrel-shaped bobbin may be formed and the contents be increased. The back row of spindles on each side are revolved at a slower rate than the front ones, and half-filled bobbins are transferred thereto in order that the yarn speed may not become too great as the bobbin approaches completion. For high speeds, self-contained spindles of the Rabbeth ring spindle type are applied, and the same are also used to carry ring bobbins when the thread has to be withdrawn from the side of the latter. A travelling apron is also provided to carry empty ring bobbins to a skip at the end of the frame.

Considerable improvements have recently been made in the methods of tensioning and clearing the yarn during winding. It is now recognised that tension applied to the thread should not be accompanied by friction with roughened surfaces, which have the effect of displacing fibres. To this end the thread may be tensioned by porcelain tubes, under and over a suitable number of which it may be taken in its passage to the bobbin. In another method the thread is passed through V-shaped grooves in a porcelain cup, and is tensioned by a small metal ball, of suitable weight for the yarn being wound, which is dropped in the cup upon the thread. A third method takes the thread over a plush-covered roller, which is revolved at the rate of 8 or 10 revolutions per minute, in the direction contrary to that in which the yarn is travelling, and is given a short lateral traverse to equalise the wear of the plush covering.

Clearing Devices.—A number of these are described under the heading of "Yarn Clearing" in Section IV. of this book. Reference is also made in this Section to the **Bottle-shaped Winder** and the **Thread Knotters.**

Speeds.—Spindles, 650 revs. per min.

Pulleys.—12 in. dia. × 2½ in., 140 revs. per min.

Gauge of Spindles.—Usually 5 in. for bobbins 5-in. lift and 4-in. head.

Power.—300 spindles per I.H.P.

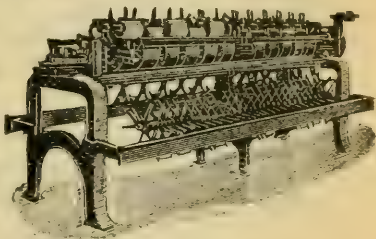
Production.—600 lb. of 30's yarn in 56½ hours every 37 spindles, or about 16 lb. per spindle.

Floor Space.—Width of frame, 5 ft. 6 in.

Rule to Ascertain Length:—Multiply half the number of spindles on one side by the gauge, and add 2 ft. 1 in. for gearing and off end.

Rule to Set a Mangle-wheel Traverse Motion :—Count half the number of teeth in the mangle-wheel; set the mangle-wheel opposite the pinion that drives it; count half the number of teeth in the rack at side of machine; set the small side of eccentric wheel on mangle-wheel shaft into gear with full side of wheel that gears in rack; set the traverse half-way of bobbin.

The Drum Winder.



Bleached, dyed, and doubled yarns are usually in the hank state, and when small quantities only of these are used, provision is made in a portion of the spindle machine (described above) for carrying the hanks upon swifts or ryces. Otherwise the Drum Winder is preferable for winding from hanks, because the thread speed is approximately uniform from beginning to end of the bobbin.

A Single Drum Winder consists of a row of drums secured upon a shaft. Each carries two bobbins, which are held in contact with opposite sides of its periphery by spindles and slotted brackets or cradles. The thread is guided from end to end of the bobbin by a guider rail actuated by either heart-cam or mangle-wheel motions. The thread is suitably tensioned by weights hung upon the ryce bosses or upon the lever carrying the lower cage. In this manner tension can be applied without friction, which would result in rubbing off the size from yarns that have been sized in the hank.

A Double Drum Frame has a line of drums down each side, and each carries only one bobbin. Such a machine is more convenient for hanks of large circumference—as linen, jute, and some worsteds—since the ryce holders need not project outwards so far as would be necessary in a single-drum frame. Also the space between the two lines can be occupied by a trough to hold full and empty bobbins, which with a single drum machine must be kept in skips on the floor.

Speed of Drums.—150 to 200 per min., for 20's to 30's single.

Production.—2 to 3 bobbins per loom.

Dimensions of a 40-drum Machine.—7$\frac{3}{8}$ in. pitch, 5 in. traverse, 26 ft. 11 in. × 4 ft. **Pulleys.**—10 in.

Cheese and Cone Winding.

Considerable quantities of warp yarn, both grey and coloured, are now wound upon straight or conical paper or metal tubes, in such a manner that cheeses or cones with self-supporting sides are formed. The flanges required by ordinary warping bobbins are thus dispensed with, carriage is facilitated, and it becomes possible to bleach or dye the yarn without requiring it to be reeled and rewound. Warping is also facilitated by the elimination of the bobbin momentum, and the excessive drag put upon the thread as the bobbins are emptied. Chief among machines of this type are the Split-drum Winder, the Self-contained "Universal" Winder, and the Camless Winder, each of which may be adapted to wind from the cop, ring bobbin, or hank.

Split-Drum Winders,

Description.—The essentials of the machine are—suitable holding arrangements for cops, bobbins, or hanks; satisfactory guide and tensioning arrangements; a drum to rotate the cheese which it builds up upon itself; a slit in the drum, to act as the guide to the thread; also suitable holding arrangement for the tube or barrel, and ultimately for the cheese built thereon, which, resting on the drum, is turned by surface contact always at the same surface speed. The distribution of the yarn is dependent upon the relationships of the circumference of the drum, the slit that guides the thread, and the diameter of the cheese.

The machine can be made for any length or diameter of cheese, and can be constructed with two-speed driving bowls to suit coarse, fine, or tender yarn, as required.

Speed.—Approximately 150 revs. per minute.

Dimensions.—Over all, 40 drums (20 each side), 5 in. traverse, to wind from bird-cage bobbins :—16 ft. 5 in. × 4 ft. 2 in. Ditto, to wind from cops or ring bobbins :—16 ft. 5 in. × 3 ft. 6 in.

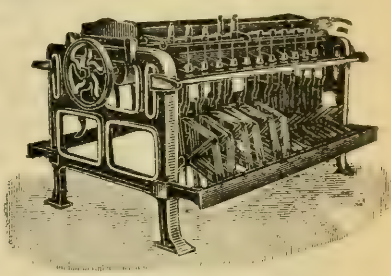
WEFT WINDERS.

Function.—To transfer weft yarn from hanks or cops to paper tubes, wood pirns, or cops of the correct size for the shuttle. The process is required with weft bleached or dyed in the hank, when the spinning cop is too large for the shuttle, and when wet weft is used for heavily picked goods.

For descriptions of the self-contained and camless winders see Section IV.

Types.—Cup Winders. Horizontal Winders.
Disc Winders. Warp Pirner.
Cop Winders.

The Cup Winder.



A central tin drum drives by means of bands a row of wharves on either side of the frame, which revolve freely upon vertical tubular studs. Immediately above there is a row of metal cups, whose interiors correspond with the conical pirn heads. Long spindles, having heavy heads and flattened ends, are passed through the pirns, and enter rectangular holes in the tops of the wharves, and therefore revolve with the latter. Motion is transferred to the pirns by wings on the under side of the spindle heads, entering into grooves upon the pirn.

Hanks are carried by ryces or swifts and cops by skewers, and the threads pass over a guider rod, which is caused to rise and fall by heart cams or scroll motions. As winding proceeds the pirn and spindle rise, and the length of the latter is so adjusted that it leaves the wharve when the pirn is filled.

Speed.—160 to 200 revolutions of tin drum.
Pulleys.—10 in. **Power.**—160 spindles per H.P.
Production.—3 to 4 spindles per loom.
Floor Space (for 60 spindles each side).—23 ft. 6 in. × 4 ft. 6 in.

The Disc Winder.

In this machine the pirns are held in contact by spindles with the bevelled edges of discs, secured upon shafts placed one at either side of the frame. Swivel joints are made between spindles and heavy heads, which are free to rise in brackets placed above the discs. Bolsters with inclined grooves upon the upper surfaces are suitably fixed to hold a spindle vertical, and a pirn head in rolling contact with a disc. Spindle, head, and pirn rise until the latter is filled, when the spindle point reaches the top of the bolster and slides down the incline to take the pirn out of contact with the disc. The thread is guided by a hook that projects in front of a disc and

is secured to a faller shaft. The discs, and therefore the pirns, are rotated at a variable speed—slower as the thread rises up the cone and quicker as it descends. Thus a uniform winding speed is obtained.

Compared with the cup frame, this machine produces a harder pirn, with longer contents and fewer breakages. It can work weaker yarns, and there is no trouble from bands or tin drum. Theoretically there should be no friction, which glazes the yarn, but this is not borne out in practice, owing doubtless to differences between the bevel of the disc and the cone of the pirn.

Speed.—220 to 260 revs. per min. **Pulleys.**—12 in.

Power.—150 spindles per H.P.

Production.—2 to 3 spindles per loom.

Floor Space.—27 ft. × 4 ft. 6 in. for 60 discs each side.

Recent developments of the above principle consist of using conical split drums, which are mounted vertically in ball bearings. The face of each drum corresponds with the cone of the pirns to be used; and the slits which determine the traverse or lift of the thread, are capable of adjustment to suit various sizes of pirns. In a second modification the discs are replaced by small cones, which are mounted with their larger ends uppermost at such an angle that their faces are evenly in contact with those of the pirns. In this manner the speeds of the two surfaces exactly correspond, and, as the pirn is made to act as a driver to the cone, friction and yarn-glazing are practically eliminated.

Cop Winders.

Cop Winders form a solid cop upon a bare spindle. A disc at the head of a spindle encloses the weft within a cup, similar to that of the cup winder, until a corresponding cone of weft has been formed, whereupon cop and spindle are pushed upwards. Pressure is applied to the spindle-head by a spring, and a quick traverse is imparted to the thread by a rod and an eccentric motion. The lower end of the spindle enters a boss at the top of a tube, which has one-half of a cam clutch at its lower end. The opposite half of the clutch is formed on the under side of a bevel wheel at the bottom of a sleeve, which encloses the tube and is constantly rotated by bevels on a driving shaft. Hank ryces are supported above the machine, and each thread in passing to the cop is taken beneath a grooved washer carried at the end of a lever, which passes

beneath the spindle boss and is fulcrumed immediately behind. The lever is balanced by a weight to permit of the thread tension raising its forward end, and connecting the two halves of the clutch to set the spindle in motion. If the thread should break, the lever and boss fall, separating the clutches, and thus stop the spindle and cop from rotating. A similar condition follows upon the completion of the cop by pushing upwards the weighted end of the lever.

This machine enables the maximum quantity of yarn to be placed within a shuttle of given dimensions, and the thread can be withdrawn from the inside of the cop, which results in better selvedges to the cloth.

Speed.—160 to 200. **Pulleys.**—10 in.

Power.—120 spindles per H.P.

Production.—2 spindles per loom.

Floor Space.—24 ft. × 4 ft. 2 in. for 60 spindles each side.

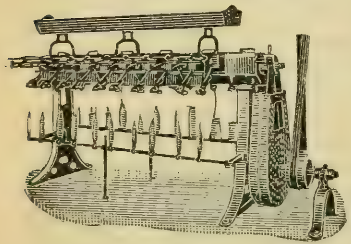
One of the most recent machines of this type is built in sections of 8, 10, or 12 spindles, and each section has an independent tin roller for driving these spindles. The spindles are mounted in revolving bolsters, and are friction-driven; they are self-contained, and run at varying speeds up to 4,000 revolutions per minute, according to the class of the creel supply from which the yarn is wound. The mechanism for building the cop consists of two separate motions—one for actuating the traverse during the winding proper (or "long chase," as it is termed) and one for the return movement when the binding of the threads takes place; the ratio between the two traverses is 3 to 1, or thereabouts. As the building proceeds and the first-named wind is completed, the tin roller driving that section of spindles ceases to revolve for a fraction of a second, to allow the thread to travel rapidly part way down the chase of the cop. Thereupon the tin roller starts again, and the chase is completed with the spindles revolving at their normal speed. The winding then proceeds as before. In order to arrest the tin rollers for the purpose mentioned, each one obtains its motion by frictional contact with discs mounted on the main driving-shaft, which are released intermittently by the crossing builder.

The base or bottom of the cop is formed by the aid of a projecting quadrant, which by contact with the lifter-chain takes up a portion thereof until the cop has attained its full diameter, at which point its action ceases

automatically. By the aid of this quadrant a wide range of adjustment is provided, so that users can adapt the system to practically any shape of base they may desire. Each section being independent of its neighbour, the stoppage arising through the breakage of a thread affects only the section in which it occurs. In the same manner one section only is affected when a stoppage occurs due to the cops having attained their full capacity. The tension arrangement is on the balanced-lever principle, and can be adjusted to suit the class of yarn wound.

Horizontal Spindle Winders.

Horizontal spindle winders are worked on the quick-traverse principle and have separate building-motions and stop-motions attached to each spindle. In these machines the yarn is wound on a supporting centre in regular helical coils, which reverse with a sharp bend, each coil crossing over the next preceding coil, binding it in its place at each crossing. The coils being in perfect alignment, they form a self-supporting spool, which will readily unwind. The machine is driven from a gear-box, arranged at one end of the frame.



From this gear-box, motion is imparted to two line-shafts, one of which drives the spindles, while the other (having an oscillating motion) operates the traverse-guides. The spindles are driven separately by skew-gear wheels. The traverse movement is operated from small quadrant arms, fixed on the oscillating shaft opposite each thread-guide. These arms are provided with a series of holes, into any of which the connection is made, and the length of the traverse is correspondingly changed.

The builders for the cops consist of screw-threaded rods, upon which rotate small sensitive wheels. At the conclusion of each traverse the wheels are caused to make part of a revolution, and in so doing to move along the rod, each one taking with it the mechanism that carries the thread-guide. When the winding of the cop is completed, the wheel encounters a projection, which puts into action an appliance for stopping the spindle.

When winding upon paper tubes each traverse-motion is fitted with a small shaper-plate, which controls the

movement of the traverse-wheel until the cop bottom is formed.

Speed.—Spindles, 2,000 revs. per minute.

Pulley.—5½ in.dia., 1 in. belt.

Floor Space.—20-spindle frame, 7 ft. 0 in. × 3 ft. 0 in.

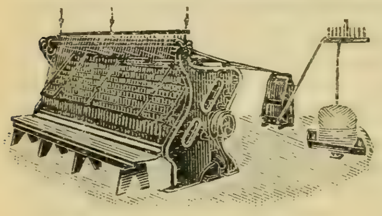
Reciprocating Spindle Winder.—The spindles of this machine also lie horizontally, but besides revolving at a very high speed, they have imparted to them a reciprocating motion, by means of which the traverse of the yarn upon the tube or pirn is controlled. The spindles are driven by friction through discs mounted thereon working in contact with the peripheries of pulleys mounted on a shaft extending the length of the frame. The reciprocating or backward and forward movement is obtained from mechanism enclosed in an oil-proof box, of which there is a separate one for each spindle. Provision is made in this arrangement for any one spindle to be run at a speed different from the remainder, for the purpose of enabling a user to obtain the highest production consistent with the class of yarn being wound.

As each layer of yarn is put upon the pirn, the outward movement of the spindle brings the tapered part or "nose" into touch with a cup or builder, the inner surface of which corresponds with the shape of the pirn. This cup is mounted upon a stationary spindle, and is free to rotate thereon with the pirn when in contact therewith. This slight impact also causes the cup to move along the stationary spindle. To limit this movement to the thickness of each layer of yarn, the upper surface is formed with fine teeth, into which enters the beak or bill of a light spring pawl. As the building of the pirn proceeds, the cone moves intermittently along the stationary spindle until the pirn is completed. At this period the cup enters into contact with a side lever, and by depressing this lever the progress of the winding is arrested.

Warp Pirning.

For this system the yarn to be wound is prepared and bleached or dyed, and, if necessary, sized, in the form of a ball or chain containing 378 ends and several thousands of yards. In the pirning machine the warp is suitably tensioned by weight rollers or ladder arrangement, and is opened out into a sheet by a coarse raddle or reed. From the latter the threads are taken over a pair of drag rollers, and thence passed to a series of Rabbeth

spindles, which are arranged in a bank, formed by a number of supporting rails, and driven by bands from tin drums. The threads are guided upon the pirns or paper tubes carried by the spindles by wires, which are operated by a building motion similar to that used on a ring frame. The resulting pirn is practically similar in all respects to a mule cop with a through tube. The completed cops or pirns are doffed after the manner of mule doffing, and as this can be quickly performed and the warp contains a sufficient length for a number of pirns, the productive capacity of the machine is very great. For



yarns of medium count and quality a single attendant can operate the machine; but an assistant is desirable when coarse counts or weak yarns have to be wound. Besides economy in production, the system has other important advantages. Thus the danger of shaded or striped pieces in the case of self-coloured goods is completely eliminated; and the winding is effected without frictional contact of the yarn with metallic or other surfaces. Hence there is no risk of glazing or burnishing, or removal of size, and colours retain their brightness. There is also a considerable economy in space, the machine itself only occupying 7 ft. × 4 ft.—to which, however, must be added a suitable length for "ratch" or tensioning and opening the warp.

Steel Hank Swifts.—In these the spokes or arms are made of tempered steel wire, and are unbreakable, strong, and light. Each pair of spokes is one continuous wire, shaped to present a straight part for the yarn to rest on. As the tendency of the wire is to spring outwards, the proper tension on the hanks is assured.

WARPING.

Warping has for its object the placing together of the threads to form a warp, in sufficient number and length, and in such a condition that they can be evenly wound upon the weaver's beam.

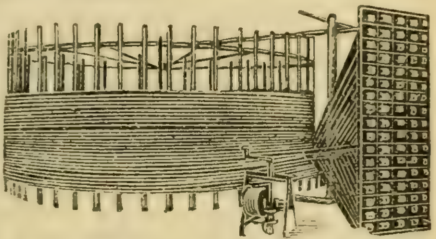
Types.—The Mill Warper. The Beam Warper.
The Cross Ball Warper. The Sectional Warper.
The Chain Warper.

The Mill Warper

Is the oldest form of warper. Its use is now mainly restricted to the making of warps for coloured goods, the slasher sizer having caused its almost entire discontinuance for grey goods.

It consists of two parts—a circular creel to contain bobbins from the spindle or drum winder, and a mill or vertical reel 5 to 18 yards in circumference.

Threads from the bobbins pass singly through the eyes of a leasing heck, and are then made fast to lease pegs at the foot of the mill.



The latter is then rotated, and at the same time the heck rises to coil the threads in spiral form upon the mill. When the required length has been obtained, a second set of pegs is placed and the threads are secured; thereupon the mill is rotated in the contrary direction, when the heck descends and places a second layer of threads upon the first, until the foot pegs are reached. Then another reversal is given to the mill, and so on until the required number of ends are obtained, when the leases are secured by bands, and the warp is withdrawn from the mill and made into a ball or chain. The foot lease is usually formed of half beers or groups of threads for the service of the beamer. At the head an end-and-end lease is formed for the service of the drawer-in or twister.

Are usually made in the following sizes :—

Circumference of Mill.	Floor Space	Circumference of Mill.	Floor Space.
12 yards	19 ft. × 12 ft.	16 yards	23 ft. × 18 ft.
14 ,, ...	21 ft. × 14 ft.	18 ,, ...	26 ft. × 18 ft.
15 ,, ...	22 ft. × 15 ft.	20 ,, ...	27 ft. × 20 ft.

Length of staves—6 ft., 6 ft. 6 in., 7 ft., 7 ft. 6 in., and 8 ft.

Eyes in heck, from 252 to 420, usually 306. Pitch—fine, 0.206 in.; coarse, 0.237 in.

Bobbins in Creel to suit heck, usually 18 high × 17 wide for 306.

Power motion pulleys—13 in. diam. × $2\frac{1}{2}$ in. wide. Driving pulley to be $7\frac{1}{2}$ in. wide.

Speed of Mills—About 170 yards per minute, which gives the following **Speeds of Pulleys**—in power motion:—

Size of Mill	12	14	15	16	18	20 yards.
Speed of Pulley ...	59	51	47	44	39	35 revs.

Average production of (say) 30's—About 42,000 hanks per week.

Attendance—One man to each mill. **Power**—$\frac{1}{2}$ H.P.

Cross Ball Warper.

Is specially adapted for warps that are to be dressed after dyeing and sizing. The yarn is taken from the creel through a stop-motion to a quick-traverse cross baller; and is built up in widely-pitched quick coils on a hollow wood tube placed on a spindle. It has many advantages over the machine last described, not the least important of which are an absence of dropped or lost ends so troublesome to the dresser, and the fact that the yarn is laid quite straight, and is in no way liable to disarrangement, as in taking it from a circular mill.

The system is confined to the production of warps containing a limited number of ends, but there is practically no limit to their length.

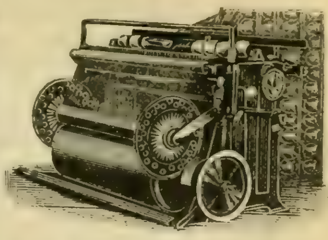
An analogous system is known as **Warp Linking** or **Chaining**. In this case the rope of threads is linked into a chain, which easily unravels for dyeing or beaming, and which can be made into a package of convenient form and size for handling.

The Beam Warper.

The principal use of the Beam Warper is in the preparation of back beams for the slasher sizer. It is also used for making warps for coloured goods when long lengths of simple striped patterns are wanted; and for winding direct upon weavers' beams when the number of threads is small.

Bobbins from the spindle or drum winder are placed in straight creels or banks or in V-creels. The beam rests upon and is turned by frictional contact with the surface of a wooden drum, which is built up on the driving shaft. A fixed reed at the back, and an expansion reed at the front, separate the threads and con-

tract them to the required width. Machines for coarse and medium counts are usually provided with stop-motions to bring the machine automatically to rest when a thread breaks. Slack yarn given off by the overrunning of the bobbins or unwinding from the beam is taken up by rollers, which are free to rise or fall within grooves formed in the framing. Machines for finer counts that will not stand the weight of the pins generally used in stop-motions, are provided with an arrangement of falling rods, by means of which considerable lengths can be unwound from the beam for the discovery of broken threads.



Measuring motions are also provided, as well as others to stop the machine when predetermined lengths have been wound.

Speeds.—40 revs. per min.

Pulley.—15 in. dia. × 2 in. wide.

Power.—One machine, .30 I.H.P.

Production.—One machine for 80 to 90 looms.

Floor Spaces.—

9/8's Machine, 16 ft. by 7 ft. 6 in.
6/4's Machine, 16 ft. by 8 ft.
7/4's Machine, 16 ft. by 8 ft. 6 in.
8/4's Machine, 16 ft. by 9 ft.

Creel.—Usually made to contain 504 bobbins.

A 9/8's machine will take in a warper's beam 65 in. from outside to outside of collar. Such a beam is 61½ in. on the wood, and the latter is $4\frac{9}{16}$ in. dia. when empty.

An expanding front comb with 504 dents in 54 in. will expand so as to have 358 dents in the same space.

Hinged V Creels.—An arrangement for facilitating the work of the operative in creeling and otherwise when attending to the bobbins mounted in that part of the creel nearest the machine. The top and bottom boards of the creel are hinged on both sides, so that it can be turned outwards at the will of the attendant by simply lifting a small rod, which operates a catch-lever.

Recently-improved V-Creel.—For reducing the time occupied in creeling, to enable the bobbins to be placed closer together, and to reduce the strain upon the yarn,

etc. The spindles in each chase or row are permanently secured in a circular metal upright, which is capable of being swivelled in top and bottom bearings. The opposite upright is of angular metal, is rigidly fixed, recessed to receive the spindle end, and fitted beneath the recesses with star-wheels, which enable the whole row of spindles to be pushed into and retained in the running position by a single stroke. Similarly a pull at any single bobbin or spindle has the effect of withdrawing the whole row from their recesses, and bringing them into such a position that an empty bobbin can be removed from its spindle with one hand and a full one slipped on by the other.

To ensure steady driving of these machines when the power is obtained from a small engine, it is advisable to transmit the power through a countershaft. The latter serves as a governor, and prevents the effect of pulsation.

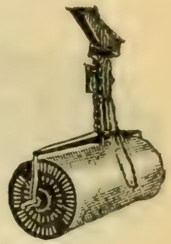
Beam Relieving Motion.—The object of this device is to prevent irregularity in the formation of beams while the yarn is wound upon their surfaces. The invention consists in the application of a pawl or ratchet motion, worked in connection with a quadrant on the silent feed principle. There are two motions to each beam, and as the beam increases in diameter and the arms are thereby raised, the device causes the beam to retain that altitude independently of and without undue pressure being exerted upon the warp threads. The pawl and quadrant serve as a temporary locking device in one direction only, until the beam is full.

Slack-Sided Beams.—These are caused by uneven tension on the threads as they leave the bobbins in the V creel. The tension is greatest in the middle, and gradually diminishes towards the sides. Beams thus wound are slightly larger in diameter where there is the least tension, and therefore cause trouble in the sizing process. This may be avoided by adopting an arrangement whereby the tension roller in the machine is made in halves, with the centre mounted in a flexible bearing, so as to admit of the two parts of the roller being mounted at suitable angles.

Overhead Run-ways.

Function.—To relieve beamers and others from the strain of lifting beams, and to facilitate the transport of these from place to place.

Description.—The rails upon which the carriers travel are fixed overhead to any convenient part of the building. They are constructed with branches to suit the different directions that the carriers are required to travel, and junctions are provided to permit of diverting the course. The carriers or trolleys are each fitted with two pairs of bowls, which run on ball bearings. The lifting blocks connected with the carriers are worked by spur or worm gearing. With these run-ways very little exertion is required to move the suspended load.



Yarn Beams for Transit.—To comply with the demand of ring spinners who deliver their yarn to the consumer already wound upon beams, the makers of these beams are imparting strength and stability thereto, so that they may withstand the rough handling to which they are subjected during transit. Among the methods adopted are:—

(1) To bore a hole out of the solid timber the entire length of the beam, and insert therein a metal tube. This tube extends beyond the beam at both ends, to constitute the pivots for the beam's axis. The tube is then secured in position by special means, and the beam is then finished off by introducing a flanged collar. This method does not increase the weight of the beam.

(2) In which the rod in the beam is solid with the middle cruciform in section and the two remaining portions round to form the axis. The wooden beam is bored with a hole of suitable size, and the rod is inserted and driven into position by hydraulic pressure. By this means the cross-section cuts its way into the wood, and each corner beds itself therein, and becomes a permanent fixture.

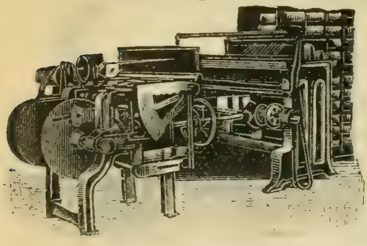
Considerable improvement has also been made in the flanges and the method of securing them to the beam, so that the evils arising from crooked flanges need no longer exist.

The Sectional Warper

Is used for the making of coloured striped warps and also grey ball warps.

V or circular creels contain the bobbins, and the warp is made a section at a time by winding the threads upon circular blocks secured upon a shaft between two flanges. The yarn is pressed sufficiently hard upon the

block to make the sides self-supporting after removal from the shaft, and also to counteract the increasing tension upon the threads due to the decreasing size of



the bobbins, which would affect to a corresponding degree the diameter of successive sections. Uniform rate of winding is obtained by gradually decreasing the speed of the block as it fills, and motions are provided for measuring the length and registering the revolutions in order that the same number may be given to each section of the same warp.

To set the presser motion when a change is made in the number of threads, counts, or width of section—

(1) With Quadrant Regulator.

Run a few revolutions without yarn, and see that the ratchet wheel is impelled one tooth for every revolution of the section spindle. The empty section block having been placed on the spindle, be careful that the flange which holds the block in its place is adjusted quite close to the edge of the block, and is securely fastened on the spindle by the screw in the flange boss. A few threads of waste "thrums" tied round the section block, and worked into each corner, prevent any warp threads from falling down between flange and ends of section block; a strip of felt or cloth nailed round the edge of each block serves the same purpose.

Fasten the yarn in hole of section block and turn the machine round half a revolution (that is, until the set-screw in boss of flange is at the bottom); then put in the lease; turn the machine another half-revolution, which will bring the screw of the flange to the top, and the lease will then be just over the measuring roller. Now set the cut-measuring motion. Lift up out of gear the double wheel in connection with the worm, and turn the numbered dial round in the direction of the figures until the hand points to the highest number. Loosen the screw which bolts the two sectors together. Allow the presser to fall against the section block, and bring the end of the toothed sector forward until it is opposite the beginning of the index of the fixed sector. This is done by means of the handle attached to the worm shaft.

As the first section will determine the size of change-wheels required on the regulator for all succeeding sec-

tions of the warp about to be made, care must be taken that the numbered discs, which record the revolutions of section spindle, are set at zero, and that the index of fixed sector is set as above. The machine will now be ready to start, and the section block can be filled with the length of yarn required for the warp.

When the necessary length of yarn has been run, the number of revolutions made by the section block, as shown by the two discs, must be noted, as also the number on the sector index standing opposite the end of toothed sector—for this last is the number of the teeth required for the change-wheel on the ratchet wheel shaft. The number of revolutions recorded by the section spindle regulates the number of teeth of the change-wheel for the worm shaft, and the number is ascertained by dividing the numbers recorded on discs by 10. For example, suppose 375 and 18 are the respective numbers. These added together make 393, which, divided by 10, gives 39 as the number of teeth required.

To take the section off when filled, relieve the friction bowls from the plate by pushing down the handle which keeps them in contact with the latter; then tighten the screw which fastens the two sectors together, and turn the worm shaft on the regulator a few turns in the direction in which it runs with the handle provided for that purpose. This will remove the presser from the filled section. The flange is then removed and the section taken off and replaced by an empty block, to which the yarn is fastened as already described. Now loosen the screw which fastens the two sectors together, and allow the index sector to fall back until the presser is against the empty block, or as far as it will go.

Before running the second section, the change-wheels (having been thus ascertained) must be put on and geared by means of the intermediate or carrier-wheel. Care must be taken that the toothed sector has been run back as far as possible by means of the handle of the worm shaft, and that the numbers 25 and 1,000 appear on the respective discs just outside the shields. This is done by drawing the carrier-wheel out of gear, turning the discs to the positions required, and then replacing the carrier-wheel.

See that the presser is in its proper position close against the empty section block; then fasten the two sectors together with the screw for that purpose—and the machine is ready for running-off all the other sec-

tions of the warp. No further alteration is required so long as the same class of sections are being made.

The measuring motion is only required for the section in each warp on which the "cut" or "piece marks" are made; but care must be taken that each section has the same number of revolutions run on as recorded on the two discs when running the first section.

To take off all succeeding sections when finished, give the worm shaft a few turns in the direction in which it runs to relieve the presser. Take off the full section, replace with an empty block as before, then turn the worm shaft the reverse way as far as possible. This will bring the presser back to the empty block, and likewise the two discs which record the revolutions to zero; then proceed as before.

The warper must always have the screw of the flange in one position, when she cuts the yarn at the completion of a section.

The number of teeth in change-wheels shown by the machine are not necessary. Any other wheels, whose proportion of teeth are the same, will do. Thus very few change-wheels are necessary.

(2) With Link Regulator.

Remove the link from the studs carried by the presser lever and quadrant, and run the first section. Upon its completion, move the studs along their slots until the link can be slipped upon them and be exactly vertical. This will occur when the stud pointers are at corresponding figures upon the scales carried by quadrant and presser lever. Before connecting the studs by the link, a mark should be made upon the end of the presser lever, and a pointer be made fast opposite to it in the slot of an arc immediately behind. Any alteration in the positions of quadrant and lever will thus be made apparent.

Speed.—100 revolutions. **Pulleys.**—14 in. × 2½ in.
Power.—.5 H.P. **Production.**—40 to 50 looms.
Floor Space.—20 ft. × 7 ft.

Running-off Machine.

When the required number of sections have been made, they are placed side by side upon the shaft of this machine, and are tightly screwed between two flanges. Next, the threads are made fast to and wound upon the weaver's beam, or (in the case of ball warps) are withdrawn and coiled into a ball.

Speed.—80 revolutions. **Pulleys.**—14 in. × $2\frac{1}{2}$ in.
Power.—.5 H.P.
Production.—1 machine for 6 or 8 warpers.
Floor Space.—3 ft. 6 in. × 7 ft. 6 in.

Press or Ball Warp Beaming Machine.

Function. — The winding of ball warps upon the weaver's beam.

The weaver's beam is placed in the hollow formed between iron drums carried by parallel shafts, which are rotated in the same direction. Iron collars are placed upon the beam ends, and pressure is applied by anti-friction rollers carried by weighted levers, which are fulcrumed upon, and can be slided along a shaft behind. The friction thus set up causes the yarn to be drawn forward, and the pressure results in a hard and level beam. The threads are opened out to the desired width by a coarse reed or wraith, into each dent of which one or more half-beers are placed. Tension is put upon the warp, to cause the threads to separate easily, by weighted mangle rollers. The drums upon each shaft are divided into sections, which can be opened out to any desired width as long as a section upon one shaft covers a gap in the other.

For yarn beams of 45 in. reed space:—

Speed.—90. **Pulleys.**—$17\frac{1}{2}$ in. × 3 in.
Power.—$\frac{1}{2}$ H.P.
Production.—One machine 30 to 40 looms.
Floor Space.—40 ft. × 7 ft. 6 in.

The Yorkshire Dressing Frame.

Is used when differently coloured threads, dyed separately in the ball state, are to be placed in their required order to form stripes and be wound upon the weaver's beam. The beam is supported between two vertical posts, of which one can be moved to accommodate different widths of beams, and driven by wheel-gearing and stepped cones. The threads from the various balls are first passed between weighted mangle rollers; but as these exert greater holding power upon warps containing more threads than others, provision is made for tensioning each warp separately by a ladder arrangement, in which the staves are removable. Each warp is opened out by grooved rollers to the width required, and the threads are arranged in their proper order, two to four ends in each dent of a reed carried in one hand of the workman. Thus the threads are properly separa-

ted, and as broken ones are pieced or replaced, the weaver is relieved from all trouble from these causes.

Speed.—80 revolutions.

Pulleys.—18 in. **Power.**—$\frac{1}{2}$ H.P.

Production.—One machine, 20 to 30 looms.

Floor Space (for 45 in. reed space beam).—8 ft. × 20 ft.

Splitting Machine.

For the purposes of "Yorkshire" dressing it is usual to prepare stock or standard colours in warps of about 2,000 ends each, and split therefrom the exact number required for a particular pattern. Such splitting may be done either by hand or machine. In the latter case the requisite number of ends is counted off, and the resultant sections are taken through a coarse dividing rail and under separate weight rollers, which rest upon a large drum and are sufficiently heavy to carry forward their sections. The warp is suitably tensioned to keep it straight and assist the sections to separate. Upon revolving the drum the several groups are passed over guides, and are delivered into separate sheets spread upon the floor or into circular cans.

Another and recent method of dealing with warps dyed and sized in the ball is to wind the yarn after sizing on to warpers' bobbins in a warp winding machine.

SIZING

Sizing is necessary for all single-twist warp yarns. Its primary object is to increase the strength and smoothness of the thread, thus enabling it to withstand the strain and friction incidental to the weaving operation. Other objects of sizing are—the increase of the weight and bulk of the thread; and the improvement of the appearance and feel of the cloth.

A considerable variety of substances are found in size mixings, of which the more important are included in the following:—

(1). Substances possessing adhesive or glutinous properties, to strengthen the yarn and fix other ingredients and all loosely projecting fibres firmly upon its surface. These include flours and starches of wheat, sago, rice, maize, and the potato; dextrine and gum tragasol.

(2). Substances to render the sized yarn soft, pliable, and smooth. These include tallow, grease, oils, wax, glycerine, and soap.

(3). Weighting substances, such as china clay, French chalk, and barytes.

(4). Substances to destroy or prevent the growth of mildew, for which purpose zinc chloride is almost exclusively employed.

(5). Deliquescent substances, to attract moisture to the sized thread, whereby it may retain its pliability and prevent the powdery substances from being rubbed off. Magnesium chloride, calcium chloride, glycerine, and common salt, are used.

Flours are used when strength and weighting substances are required. Starches increase the bulk of the thread. Farina or potato starch is used because of its cheapness, and is suitable for bleached and coloured yarns because it does not dull the colours to the same extent as do flours. Dextrine and Gums are used when very heavy percentages of weight (say from 100 to 200 per cent.) are wanted. Tragasol is a solution of a pure natural gum in jelly form, of considerable value where strength and smoothness are wanted. It firmly binds weighting substances upon the yarn, and effectually prevents "dusting" or rubbing off of the size during weaving. It also gives a smoothness and finish to the yarn and cloth. Tallows of good quality set hard and firm upon the yarn Cocoanut and Palm Oils are fairly good softeners, and are cheap; but they melt at low temperatures, are liable to decomposition, and are dark-coloured: therefore they are generally used along with other softening ingredients. Castor Oil and Glycerine are excellent softeners, but if used alone they darken the colour of the size, and give to the cloth a sticky, greasy feel. Paraffin and Japan Waxes increase the smoothness of the sized thread, set hard upon it, and have high melting points; but they do not mix well. They should be used for grey goods only, as they are difficult to remove in bleaching processes, and cloth containing them comes up blotched after dyeing or printing. Both hard and soft Soaps may be used; they dissolve fatty ingredients, and cause them to mix well, cause china clay to boil thin, and prevent its spurting. But if used along with the chlorides of magnesium, zinc, or calcium, or with Epsom salts, the size is liable to become lumpy, and the antiseptic properties of the zinc chloride are interfered with.

China Clay is the principal weighting substance for grey yarns, being used because of its high specific gravity, easy assimilation with other ingredients, and smoothness. French Chalk is better in colour, but is not

so heavy and is more costly. Sulphate of Baryta is heavier than china clay, but is more gritty and harsh when on the yarn. Sulphate of Magnesia (Epsom salts) and Sulphate of Soda (Glauber's salts) are chiefly used for weighting bleached and coloured yarns and cloth.

With a size containing flour and tallow there is a tendency towards the development of mildew. This is a growth originating from and subsisting on these substances. It is liable to develop at any time either during the manufacture of the size, the weaving of the cloth, or even after a considerable lapse of time from its completion and delivery. In its first stage it may be removed from a fabric by washing, without leaving stain or injury; in the second it may be washed off, but leaves a stain or discoloration; and in the third it attacks the fibre and weakens the fabric to a considerable extent. Substances to prevent its occurrence—termed "Antiseptics"—are therefore necessary. Of these, Zinc Chloride has been found most satisfactory, and a sufficient quantity of this substance included in the size composition will effectually destroy or prevent the formation of such growths. It also adds to the weight of the yarn. Carbolic Acid and Borax have antiseptic properties, but the smell of the first and the colour of the second render them unsuitable for the purpose.

Magnesium Chloride is the principal deliquescent substance used in sizing, because of its powerful attraction for moisture. It also adds to the weight of the yarn. It is sometimes called "Anti," but this should not be understood to mean that it is a preventive of mildew: the contrary is the fact, for the moisture it attracts is distinctly favourable to the development of mildew.

Soda is added in small quantities to neutralise any free acid given off in a mixing and prevent the formation of "iron-mould." Aniline or Indigo Blue is also added to take away the yellow tinge of the size.

SIZING INGREDIENTS:
Selection and Testing.

Adhesive substances should be examined with respect to their colour, smell, moisture, adulterations, amount of gluten, and consistency. The colour is compared by placing samples side by side and flattening their surfaces so that they may be in contact with each other. A musty or mouldy smell indicates decomposition. The amount of moisture may be ascertained by weighing a sample and drying in an oven. Mineral adulterations

are left as a residue when a sample is burned over a bunsen flame; others reveal themselves when a paste is formed by boiling, and afterwards allowed to cool in a bowl. It will then set into a firm mould, and on removing from the bowl other ingredients are seen on the surface. The latter test is also used to ascertain the consistency or strength of flour. The firmness of the mould, tenacity of the paste, and length of time elapsing before it runs to water determining the value. Quantity of gluten is ascertained by running water through a muslin bag containing a sample of the flour. After the water has ceased to leave the bag a milky colour, it is removed and the quantity and strength of the gluten left gives a good indication of the value of the flour.

Softeners should be examined with respect to colour, hardness, specific gravity, smell, melting point; China Clay, Chalk, Barytes, for colour and freedom from grit.

Zinc and Magnesium Chlorides can only be satisfactorily tested by expert chemists. Zinc chloride can be bought in the solid and in the liquid conditions. In the latter state it is usually at a strength of 102 degrees Twaddell, or a specific gravity of 1.51, at which strength one gallon will weigh 15.1 lb. and contain about 35 per cent. of solid zinc chloride. Magnesium chloride is usually 56 degrees Tw., or equal to 1.28 specific gravity and 12.8 lb. per gallon, or 24.5 per cent. of solid substance. A gallon of water weighs 10 lb.

Maize (" Indian Corn ") Starch.

Starch made from maize (" Indian corn ") is said to be more uniform in its effect on warps than is potato, wheat, or any other kind of starch.

Its condition remains constant for a longer period, and is more to be depended upon. It penetrates the fibre more thoroughly, and adds strength thereto, without shewing a clinging action on being separated from its neighbouring threads.

Twaddell Hydrometer Degrees.

Zero on the Twaddell Hydrometer equals a specific gravity of 1; in other words, a Twaddell hydrometer immersed in pure water registers 0.

Every 1 deg. Twaddell = .005 of specific gravity; and starting at 0 on the Twaddell hydrometer, which equals specific gravity of 1, we have—

1 deg. Twaddell = Specific gravity of 1.005.
2 deg. Twaddell = Specific gravity of 1.01, etc.

Comparison of Hydrometer Scales (Twaddle, Baume, and Specific Gravity).

Twaddle.	Baumé.	Specific Gravity.	Twaddle.	Baumé.	Specific Gravity.	Twaddle.	Baumé.	Specific Gravity.
0	0	1·000	52	29·7	1·260	112	51·8	1·560
1	0·7	1·005	54	30·6	1·270	114	52·4	1·570
2	1·4	1·010	56	31·5	1·280	116	53·0	1·580
3	2·1	1·015	58	32·4	1·290	118	53·6	1·590
4	2·7	1·020	60	33·3	1·300	120	54·1	1·600
5	3·4	1·025	62	34·2	1·310	122	54·7	1·610
6	4·1	1·030	64	35·0	1·320	124	55·2	1·620
7	4·7	1·035	66	35·8	1·330	126	55·8	1·630
8	5·4	1·040	68	36·6	1·340	128	56·3	1·640
9	6·0	1·045	70	37·4	1·350	130	56·9	1·650
10	6·7	1·050	72	38·2	1·360	132	57·4	1·660
12	8·0	1·060	74	39·0	1·370	134	57·9	1·670
14	9·4	1·070	76	39·8	1·380	136	58·4	1·680
16	10·6	1·080	78	40·5	1·390	138	58·9	1·690
18	11·9	1·090	80	41·2	1·400	140	59·5	1·700
20	13·0	1·100	82	42·0	1·410	142	59·9	1·710
22	14·2	1·110	84	42·7	1·420	144	60·4	1·720
24	15·4	1·120	86	43·4	1·430	146	60·9	1·730
26	16·5	1·130	88	44·1	1·440	148	61·4	1·740
28	17·7	1·140	90	44·8	1·450	150	61·8	1·750
30	18·8	1·150	92	45·4	1·460	152	62·3	1·760
32	19·8	1·160	94	46·1	1·470	154	62·8	1·770
34	20·9	1·170	96	46·8	1·480	156	63·2	1·780
36	22·0	1·180	98	47·4	1·490	158	63·7	1·790
38	23·0	1·190	100	48·1	1·500	160	64·2	1·800
40	24·0	1·200	102	48·7	1·510	162	64·6	1·810
42	25·0	1·210	104	49·4	1·520	164	65·1	1·820
44	26·0	1·220	106	50·0	1·530	166	65·6	1·830
46	26·9	1·230	108	50·6	1·540	168	66·0	1·840
48	27·9	1·240	110	51·2	1·550	170	66·4	1·850
50	28·8	1·250						

Specific Gravity $= 1 + {}^\circ\text{Twaddle} \div 200$

$= 144.3 \div (144.3 - {}^\circ\text{Baume})$

°Twaddle $= 200\ (\text{S.G.} - 1)$

°Baume $= 144.3\ (1 - 1/\text{S.G.})$

Comparison of THERMOMETER Scales of Celsius or Centigrade (C.), Fahrenheit (F.), and Reaumur (Re.).

Degrees.			Degrees.			Degrees.		
C.	F.	RE.	C.	F.	RE.	C.	F.	RE.
0	32·0	0·0	34	93·2	27·2	68	154·4	54·4
1	33·8	0·8	35	95·0	28·0	69	156·2	55·2
2	35·6	1·6	36	96·8	28·8	70	158·0	56·0
3	37·4	2·4	37	98·6	29·6	71	159·8	56·8
4	39·2	3·2	38	100·4	30·4	72	161·6	57·6
5	41·0	4·0	39	102·2	31·2	73	163·4	58·4
6	42·8	4·8	40	104·0	32·0	74	165·2	59·2
7	44·6	5·6	41	105·8	32·8	75	167·0	60·0
8	46·4	6·4	42	107·6	33·6	76	168·8	60·8
9	48·2	7·2	43	109·4	34·4	77	170·6	61·6
10	50·0	8·0	44	111·2	35·2	78	172·4	62·4
11	51·8	8·8	45	113·0	36·0	79	174·2	63·2
12	53·6	9·6	46	114·8	36·8	80	176·0	64·0
13	55·4	10·4	47	116·6	37·6	81	177·8	64·8
14	57·2	11·2	48	118·4	38·4	82	179·6	65·6
15	59·0	12·0	49	120·2	39·2	83	181·4	66·4
16	60·8	12·8	50	122·0	40·0	84	183·2	67·2
17	62·6	13·6	51	123·8	40·8	85	185·0	68·0
18	64·4	14·4	52	125·6	41·6	86	186·8	68·8
19	66·2	15·2	53	127·4	42·4	87	188·6	69·6
20	68·0	16·0	54	129·2	43·2	88	190·4	70·4
21	69·8	16·8	55	131·0	44·0	89	192·2	71·2
22	71·6	17·6	56	132·8	44·8	90	194·0	72·0
23	73·4	18·4	57	134·6	45·6	91	195·8	72·8
24	75·2	19·2	58	136·4	46·4	92	197·6	73·6
25	77·0	20·0	59	138·2	47·2	93	199·4	74·4
26	78·8	20·8	60	140·0	48·0	94	201·2	75·2
27	80·6	21·6	61	141·8	48·8	95	203·0	76·0
28	82·4	22·4	62	143·6	49·6	96	204·8	76·8
29	84·2	23·2	63	145·4	50·4	97	206·6	77·6
30	86·0	24·0	64	147·2	51·2	98	208·4	78·4
31	87·8	24·8	65	149·0	52·0	99	210·2	79·2
32	89·6	25·6	66	150·8	52·8	100	212·0	80·0
33	91·4	26·4	67	152·6	53·6			

$C = \frac{5}{9}(F - 32)$. $R = \frac{4}{9}(F - 32)$. $R = \frac{4}{5}C$.

$F = \frac{9}{5}(C + 32)$. $F = \frac{9}{4}(R + 32)$. $C = \frac{5}{4}R$.

SIZE MIXING.

The secret of preparing size lies in the boiling. Every granule of the starch used should be opened, otherwise its full sizing value is not obtained. Size should be cooked, so that its full adhesive properties may be brought out; it will then adhere to the yarn, penetrate it, and, when dry, cement the fibres together so that they may withstand the chafing action of the working parts of the loom with which the warp comes in contact. The value of size lies in the strengthening, lubricating, and softening of the yarn, so as to render it strong, smooth, and pliable.

The composition of a size mixing is determined by the nature of the yarn, its counts, weight of cloth to be woven—*i.e.*, number of ends and picks per inch—whether the cloth is to be used in the grey state or bleached, dyed, or printed, weight to be added, feel desired, and condition of the atmosphere of the weaving shed as regards humidity.

It will be clear that hard and fast rules for proportioning size ingredients are of little use, owing to variation of their qualities, as well as circumstances under which they are used. But generally softeners will form 7 to 14 per cent. of the total weight of the size; for antiseptic purposes 3 per cent. of zinc chloride will suffice. The proportion of zinc is sometimes stated as 8 per cent. of the flour or starch used, and 5 to 10 per cent. of the magnesium chloride, for deliquescent purposes. Both of the latter quantities may, however, be exceeded when it is desired to increase the weight by their means. China clay being the principal weighting agent, its proportions depend upon the weight to be added to the cloth. As to adhesives, wheat flour is invariably used in heavy sizing, because of its larger quantities of gluten, while sago is used for pure size, fine reeds, and bleaching cloths. The use of farina and other starches is determined by the feel and appearance of cloth desired, as well as the cost of the size.

When farina is used in a mixing, it should never be allowed to boil more than twenty minutes; otherwise its consistency is lost. Nor should more than a day's supply be prepared at a time.

Size mixings are classed as light, medium, and heavy, and are further distinguished by the proportions of size and yarn. Thus a 20 per cent. size means that to every

100 lb. of yarn 20 lb. of size are added, which increases its weight to 120 lb. A light size is anything up to 25 per cent., a medium size from 25 to 50 per cent., and a heavy size anything above 50 per cent.

In the preparation of size mixings it is well to remember that one which may add 50 per cent. of weight to very soft-twisted yarns may probably add only 40 per cent., or even less, to hard-twisted yarns. When yarns variable in twist have to be sized, the size mixing should always be made thinner in density for the hard than for the soft, otherwise the size will not penetrate the interior of the thread, but will adhere to the surface.

So far as weaving qualities alone are concerned—and such only are necessary when the cloth is to be afterwards bleached, dyed, or finished—the addition of 5 to 15 per cent. of a size consisting of adhesive and softening substances is sufficient. We have, therefore, such mixings as the following :—

Wheat flour, 92 per cent. Tallow, 8 per cent.	Sago flour, 92 per cent. Tallow, 8 per cent.
Flour, 93 per cent. Tallow, 5 per cent. Soap, 2 per cent.	Tallow, 9 per cent. Sago, 24 per cent. Farina, 67 per cent.

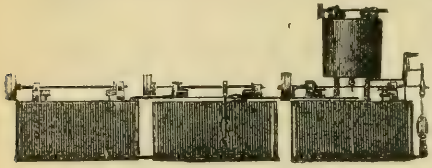
Tragasol.—Is obtained in the form of a natural gummy product, from the seeds of tropical plants, leguminosal. It is a tough, aqueous jelly, containing the maximum quantity of the true gum, and in a pure state is practically without colour, taste, or smell. Tragasol seems to enter not merely in admixture, but into combination, with all starches, and also with many other ingredients used in sixing.

Olex.—A substitute for tallow or paraffin wax, particularly for use in sizing for coloured goods, and especially for greys that have to be bleached, dyed, or printed. Is soluble and neutral, and will work along with any size. It is used in the same proportion as tallow or wax, and is much cheaper.

Size Mixing Apparatus.

With a pure size, containing only adhesive and softening substances, the process and apparatus necessary for mixing are equally simple. Flour, sago, or farina are mixed with water, three or four pounds to

the gallon, and boiled along with the tallow, etc., from four to six hours. It is then ready for use. Wheat flour is, however, often steeped from two to six weeks before using. This lessens the tendency to mildew, gives a smoother feel to the yarn, and renders the gluten more active.



For other mixings a special plant is necessary in order that the ingredients may be brought together in such a manner as will ensure thorough admixture. Such a plant may consist of three wood becks or cisterns and a boiling pan. The becks are connected by pipes and fitted with brass force pumps and agitators. In the first beck the flour is mixed with equal weights of water and allowed to ferment, it being kept from settling meantime by the agitator. The second is used for diluting the fermented flour to the desired strength. The third is the mixing beck. Clay, water, soap, and tallow are boiled in the pan (50 to 60 lb. of clay to the gallon of water), and are then run into No. 3 beck, in which fermented flour has been previously boiled one to two hours. Magnesium chloride is next boiled and brought to 56 degrees Tw. at 120 degrees F., and passed into the mixing beck, after which zinc chloride, boiled and reduced to 102 deg. Tw. at 120 deg. F., is added along with the blue colouring matter. The whole is then thoroughly boiled, after which it is ready for use. The zinc is sometimes added at an earlier stage should mildew develop. Water is, of course, an essential element in size mixing, the amount varying with the nature and quality of the materials used and the percentage of size to be added to the yarn. It is customary to add sufficient for the preparation and blending of the various ingredients, and afterwards add further quantities to reduce the mixing to the desired strength. This is usually ascertained b the Twaddell Hydrometer, and it is important to remember that when using such instruments readings should be taken at one standard temperature.

Speed.—25 revs. per min.

Pulleys.—18 in. dia. × 2 in. **Power.**—$2\frac{1}{2}$ I.H.P.

Floor Space.—Cisterns usually 8 ft. long × 4 ft. wide × 4 ft. deep with about 1 ft. floor space between each cistern.

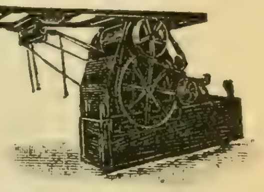
SIZING MACHINERY

Function.—The application of size to yarn.

Types.—The Ball-warp Sizer; the Dresser Sizer; the Slasher; the Hank Sizer.

BALL-WARP SIZING MACHINE.

A warp in the form of a loose rope is taken through a long trough containing size, fitted with rollers near the bottom. By passing under and over these rollers, the threads are flattened out, so that every one comes into contact with the size. Squeezing rollers press out any excess of size. The warp is then dried by passing round steam cylinders, and is afterwards wound upon the weaver's beam by the press-beamer.



With this method the sized yarn can be thoroughly cooled and "conditioned" before beaming. As there is practically no tension upon the yarn during the process, its elasticity is not impaired. If additional weight or strength be wanted, the warp can be again passed through the size. The process is also convenient for short warps; but in other cases it is expensive, as separate machines and handling are necessary to size, dry, and beam a warp.

Drying Machine.

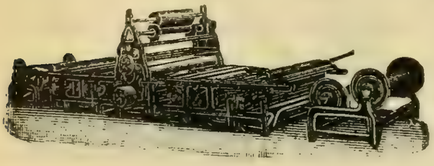
This consists of a number of cylinders arranged either vertically or horizontally. The cylinders are heated by steam, and the warps are passed round the cylinders the requisite number of times for efficient drying.

From the drying cylinders the warps are taken to the warp dressing frame, the ball beaming machine, or the warp winding machine. If intended for dressing or winding, the warps are first put through a splitting machine, which divides the warp into any required number of ends.

THE DRESSER SIZER.

This machine sizes, dries, and beams a warp in one operation. It is divided into two portions of similar construction, and which treat the yarn in the same manner, and the weaver's beam is placed in the centre of the machine. The threads to form the warp are divided over a number of back beams prepared by the beamer.

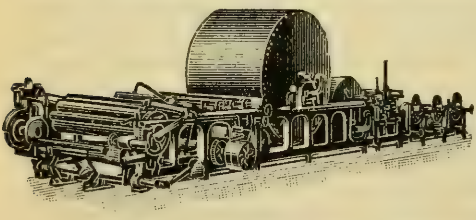
half of which are placed at either end of the machine. After passing in pairs through the dents of a reed, the threads are taken between two sizing rollers, the lower of which revolves in a size trough and takes size upon its surface to the contact point where it is pressed into the threads. Emerging, the threads are divided by a rod, next deflected by a reed to come into contact with the bristles of a revolving brush to lay all loose fibres, and again separated by rods and a reed. Drying is effected by heated air being thrown through the sheet of threads by a fan which is contained within a well, formed by steam chests. At this point the threads from the two ends of the machine are united together, passed through leasing healds and a reed, and finally wound upon the weaver's beam.



This process imparts to yarn the highest possible degree of strength and smoothness; but—because of the high cost, due to the slowness at which the operations proceed, and to the highly skilled labour necessary—it is now only used for the very finest yarns, or in cases where the qualities above mentioned are essential.

THE SLASHER SIZER.

This is now in general use for the sizing of yarns, it having almost entirely replaced the above-described machines.



A number of back beams, containing in the aggregate sufficient threads to form a warp,. and length for many weaver's beams, are placed in a creel at the rear of the machine; and the threads, by passing under and over each other, are combined into a single sheet. In this form they are taken beneath a roller, which is immersed in boiling size contained within a shallow box. One or two pairs of squeezing rollers complete the saturation of the threads, and press out any excess of size. The yarn is then dried by contact with the surface of large steam cylinders, the considerable area of

which allows of this process being rapidly performed, and cooled by fans, as far as the speed at which it moves will permit. The threads at this point adhere firmly together, and separation is effected by a series of dividing rods, each of which is passed beneath the threads from a single back-beam. An expansion reed completes the separation of the threads, and also contracts them to the proper width for the weaver's beam. The latter is driven frictionally, so that its speed may be varied to compensate for its constantly increasing diameter, and thus wind the yarn at a uniform speed equal to that at which it is given off by the draw roller. The latter is driven positively, and is connected by a long shaft with the squeezing rollers. In this manner undue tension upon the yarn is avoided. A slow-motion arrangement enables the machine to be run very slowly instead of being entirely stopped when full beams are to be replaced or dropped ends taken up.

Slashed yarn has not the smoothness nor the elasticity of dressed or even of ball-sized yarn, but these qualities are imparted in degrees sufficient for the weaving of low and medium numbers, and the cost is considerably less.

Speeds.—200 revs. per min.

Pulleys.—13 in. dia. × 3 in. wide.

Power.—One machine, 1½ I.H.P.

Production.—One machine = 300 looms.

Floor Space.—A machine with 6 ft. and 4 ft. drying cylinders and of the following sizes:—

9/8's......32ft. by 8ft. 6in.	6/4's......32ft. by 9ft.
7/4's......32ft. by 9ft. 6in.	8/4's......32ft. by 10ft.

A 9/8's machine will take in a weaver's wood beam 62 in. from outside collar to end of pivot, or an iron beam 60 in. long. A 9/8's sizing machine, with 7 ft. and 5 ft. tin drying cylinders, working 10 hours a day on dhooties, consumes 3,125 lb. of steam at 8 lb. per sq. inch pressure.

Size Circulating Sow-Box.—For ensuring an equal distribution of size on the warp yarn. It is divided into two compartments arranged at different levels, and each provided with copper boiling pipes. The boiling of the size takes place in the lower compartment. The size entering therein is obtained from an ordinary boiling beck by means of a feed pump, and the supply is maintained at a constant level by a float roller and automatic feed valve. A rotary pump fixed to the side of this compartment raises the size from the lower to the upper

chamber, and delivers it at different points in the chamber. A division between the two compartments is provided with overflow holes to allow the surplus size to pass back to the lower compartment as the circulation is kept up. In front of the feed pipe and the pump is fixed a brass sieve, to prevent any impurities or lumps from entering the upper chamber.

Warp Yarn Dryer.—To remove the natural moisture contained in warp yarn before it enters the slasher sizing machine, thus making it more suitable to receive the sizing ingredients. Consists of a small chamber furnished with steam pipes, and carrier-rollers to conduct the yarn round the pipes, whereby the moisture contained in the yarn is driven off. The chamber is interposed between the creel of the sizing machine and the carrier-roller, which conducts the warp yarn from the beam and delivers it to the size-box.

The advantages derived from the use of the above apparatus may be augmented by the introduction of a tension regulator, which automatically keeps the yarn in a slack condition during the time it is passing into the size-box. This apparatus comes before the dryer, and consists of a series of rollers, one of which works in conjunction with tension levers. These levers carry a small revolving roller under which the yarn passes, and as the levers are moved in a radial direction the tension on the yarn is altered accordingly.

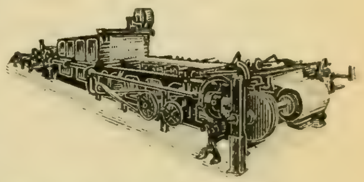
The drying power of the cylinders of a sizing machine can be greatly increased by applying to the ends a coating of non-conducting material. This addition further ensures the drying of the outward edges of the warps. The coating may consist of a number of sections of cork, fixed in position by means of the ordinary nuts of the cylinder stay-bolts. The usual washer under each nut is replaced by a special device, consisting of a ring or washer having an up-turned bolt extension capable of receiving a clamping plate. When the nuts are screwed up, these bracket-washers are held firmly, and the plates are caused to press upon the sections of cork to bind the same to the face of the cylinder.

AIR DRYING SYSTEM.

This system is specially adapted for dealing with delicate yarn, and where quality of output is of greater importance than quantity. Instead of passing the yarn over and under steam-heated cylinders, it is subjected to currents of dry air, produced by fans or air propellers

enclosed in a drying chamber. The air chambers are arranged vertically or horizontally; but the creel, sow box, and beaming section are the same as in the cylinder machine. The chief advantage of this system is that the strength, elasticity, and rotundity of the yarn are preserved to a greater extent, and also the "cover," as far as is practically possible. The machines are made the same width as those of the cylinder type. but the length varies according to the system adopted.

Horizontal Type.



I.—In this type the principle consists in forcing heated air into a drying chamber divided up into compartments arranged so that the heated air follows in zigzag fashion the way in which the warp is guided.

The heater is placed under the drying chamber, and consists of a strong cylindrical shell, into which live steam enters at one end, the condensation therefrom being liberated at the opposite end through a suitable outlet pipe. The heater is provided with tubes, through which the air is forced by a fan, and on its way to the drying chamber encounters a spreading device. The partitions in the drying chamber are of wood, and are arranged so that the warp threads are guided through them by passing over suitable rollers. The yarn and the air both travel in the same direction. To prevent the yarn from touching the full surface of the rollers, they are provided with special metal longitudinal ribs, placed at suitable intervals. The rollers run in special bearings to ensure freedom, and enable the draught of air to assist the passage of the yarn and to minimise the tension. The yarn enters the drying chamber between guide-rollers which revolve more slowly than the speed of the yarn passing between them. The lower one of these rollers is driven by banding from the size box. The moist air is discharged through an outlet at the top of the chamber. The top part of the chamber is also fitted with an economiser for partially heating, by means of the exhaust moist air, the cold air from outside before it encounters the fan.

This type of machine is sometimes fitted with a circulating size-box in which the size from a cavity feed-box is made to be continually on the move. This cavity feed-box is provided with a sieve for preventing any dirt or

scum from the size entering the sow-box proper. The circulating action is set up by means of a small pump, which causes the size to be continually overflowing from the sow-box back into the cavity feeding-box. This system of drying can also be worked in conjunction with revolving steam-heated cylinders, placed between the creel and the size-boxes, where yarn is bleached and dyed on the warper's beam, and is required to be dried before entering the separate size-boxes.

An important feature in these machines is, that users can often run them from one to three months without having loose threads or runners on the rollers inside the drying chamber.

II.—In this type the machine is supplied with four steel heaters, either 9 ft. or 12 ft. long, as preferred. These heaters are composed of steel tubes two inches in diameter, and are coupled up with the necessary steam feed and outlet pipes, with steam traps. Air is exhausted through the heaters by a powerful fan.

Floor Space:—

9/8 with 6/4 Chamber	38 ft. 0 in.	10 ft. 0 in.
6/4 ,, 6/4 ,, ...	38 ft. 0 in.	10 ft. 6 in.
7/4 ,, 7/4 ,, ...	38 ft. 0 in.	11 ft. 0 in.
8/4 ,, 8/4 ,, ...	38 ft. 0 in.	11 ft. 6 in.

Pulleys.—14½ in. dia. **Speed.**—160 revs. per min.

Vertical Type.

I.—In which the drying chamber consists of a series of radiating tubes fixed horizontally and vertically in the chamber, through which live steam passes. These tubes are joined by means of elbows at the ends. At the top of the chamber is a winch or spider roller, over which the warp passes. The yarn, on leaving the warp beam rollers, goes under a roller and is immersed in the size trough, the excess of size being pressed out by a squeezing roller. The yarn then ascends directly to the top of the chamber, over a winch roller, and down again, passing on its way a series of fans. These fans blow the hot air through the threads, causing them to vibrate and to dry quickly. When a second drying is necessary, the yarn again passes through the chamber by way of a small roller, mounted on a level with the winch mentioned. The yarn then encounters the additional heat of a second set of pipes, and is again brought under the influence of the fans. The yarn then passes under a tension roller,

through opening rods, onwards to the weavers' beams in the usual manner.

In this system the point of contact between the size box and the first roller is so great that the yarn becomes partially dried, and not liable to deposit thereon some portion of its size.

II.—In which the drying chamber is divided into two sections, one above the other, with a number of vertical partitions between the warp threads. The lower chamber contains heaters for warming the air, the upper one constituting the drying chamber proper. The yarn from the size-box is conveyed by guide-rollers at the top and bottom of the combined chamber between the vertical partitions, and a fan is employed to draw the air from the drying compartments. Baffle plates are fixed to the partitions at suitable distances apart, for the purpose of deflecting the air and assisting in the drying process. On leaving the chamber the warp is treated in the ordinary manner.

HINTS ON SIZING.

Successful sizing requires thorough penetration and saturation of the yarn; thorough and rapid drying, without scorching; proper distribution of the yarn; and the making of a hard, uniform beam.

If the yarn comes from the sizing machine too stiff or too soft, it will not weave well, there will be a diminution of output of cloth, and the quality will be impaired. Weavers assert that "half the weaving is done in the tape-room," inasmuch as good results cannot be obtained from a poorly sized warp.

Softness of warps is sometimes attributable to the water of condensation thinning down the size.

Avoid burning or scorching the warp threads.

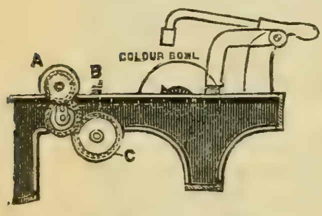
Imperfect drying sometimes causes the threads to stick to one another while on the beam.

Surface sizing, in which the size lies on the yarn instead of penetrating it, results in the size being rubbed off in weaving. It is due to the size being too thick, and not sufficiently boiled.

Avoid—Hard and boardy yarn, undersized yarn, soft beams, irregular or rough beams, beams with bad threads, excessive breakages, waste on end piecings, stains and discoloured yarns.

MARKING OF CUTS.

For measuring and marking the yarn into "cuts" sufficient to weave a given length of cloth, it is taken, after drying, over a measuring roller (14.4 inches in circumference) which is thereby revolved. A wheel upon the end of the roller shaft drives, through a carrier, one upon a short stud that has at the other end a single worm. The latter drives a wheel (called the "bell wheel") of 45 teeth, carried by a shaft having also a cam, so formed as to give at each revolution an abrupt fall to a striker-lever supported upon its surface. When this occurs, the yarn is deflected upon a bowl placed beneath, whose surface is moistened with colouring matter to mark the threads.



The ratio between the tin roller and stud wheels determines the length between the marks, the bell wheel being unchangeable.

Rules for Marking Motions.

Tin roller A, 14.4 inches circumference. Bell wheel B, 45 teeth. A set of change wheels includes 17 to 120 teeth.

Cir. of Roller-wheel × Bell-wheel = 648 inches or 18 yards.

$$(1)\quad \frac{648}{\text{Mark in inches}} = \frac{18}{\text{Mark in yards}} = \frac{\text{Roller-wheel}}{\text{Stud-wheel C}}$$

EXAMPLES.

FOR 40-yards Mark:—The ratio is here $\frac{18}{40}$, and any pair of wheels bearing that ratio will be correct, thus $\frac{18}{40}, \frac{27}{60}, \frac{36}{80}, \frac{45}{100}, \frac{54}{120}$

FOR $40\frac{1}{2}$-yards Mark:—

$\frac{18}{40\frac{1}{2}} = \frac{4}{9}$, therefore $\frac{20}{45}, \frac{24}{54}, \frac{28}{63}, \frac{32}{72}, \frac{36}{81}, \frac{40}{90}, \frac{44}{99}, \frac{48}{108}, \frac{52}{117}$

FOR 40 yards 6 inches, or 1,446 inches:—Here the ratio is $\frac{648}{1446}$. Dividing numerator and denominator by 648, we obtain $\frac{1}{2{\cdot}231}$ Multiplying the latter by numbers such as will give the nearest whole number for a denominator, we obtain $\frac{26}{58}, \frac{39}{87}, \frac{52}{116}$

(It will be understood that in all of the above pairs of wheels the numerator represents the roller-wheel and the denominator the stud-wheel.)

(2) $$\frac{648 \times \text{Stud-wheel}}{\text{Roller-wheel}} = \text{Mark in inches.}$$

(3) $$\frac{648 \times \text{Stud-wheel}}{\text{Mark in inches}} = \text{Roller-wheel.}$$

(4) $$\frac{\text{Mark in inches} \times \text{Roller-wheel}}{648} = \text{Stud-wheel.}$$

☞ For Tables giving Tin Roller-Wheels and Stud-Wheels for various Lengths of Cuts, see pp. 319-323.

Dhooty Marking Motion.—For use in sizing yarn employed in weaving shawls and similar goods requiring marks for tabs, etc., besides those for ticking off the cut lengths. The motion consists of an ordinary shawl cam, which revolves once during the passage of each shawl length, and causes the striker with which it is connected to mark the warp. Through a train of wheels, motion is transmitted from this cam to an outer one, which revolves once for every series of shawl's lengths. Upon the periphery of this latter cam rest the ends of two timing levers, mounted upon separate shafts, which in turn carry independent striking hammers. These shafts also form the fulcra for two distance levers, the outer ends of which rest upon independent marking discs. These discs, which may be termed the tab-marking discs, are each provided with an aperture through which the ends of the levers fall on the completion of a revolution, causing their respective hammers to mark the cloth at the periods required, and thereby indicate the tab and cutting distances. By adjusting the above discs, any length of tab can be made or any length of cut

To rectify the encroachment upon the warp threads for the first shawl of the next series, a retarding motion comes into operation simultaneously with the making of the last tab mark. This consists of a pivoted lever, the end of which disconnects the cam-driving wheel from the measuring-roller wheel; but as soon as the timing levers assume their normal positions, the two wheels fall into gear again and the marking proceeds as before.

Friction Controlling Device.—For imparting regular tension during winding on the beam, preventing slack places thereon, and making the warp uniform throughout the whole "section."

Consists in the application of a chain and springs to the weight of the ordinary presser lever. The lower end of the spring is connected to a cross-bar, carried by two curved rods secured to a base-plate fixed on the floor below the presser-shaft. The cross-bar is held in position on the rods during the building of the warp beam by a catch pivoted to the base-plate. This catch has its free end held in a raised position by a spring. As the ordinary lever is raised by the depression of the presser cradle the tension on the springs increases, and continues to do so until the beam is full. Means are also provided in connection with this mechanism for increasing the pressure on the friction discs with a similar object.

STEAM CONSUMPTION IN SIZING MACHINES.

The cost of steam consumed in sizing warps is an item of expenditure that must be taken into account in estimating the value of a piece of cloth. All forms of sizing machines, whether the Scottish or other, drum or air-drying machines, have heating arrangements, and consequently are provided with steam-traps to collect the condensation water. This condensation water affords a fairly reliable means for calculating the amount of steam used by the sizing machine in a certain time—provided the steam-trap is in proper working order, so that no water of condensation can remain in the cylinder or pipes. By measuring the water of condensation, the known amount of water thus obtained affords an indication of the amount of water it is required to vaporise to deliver to the pipes and the machine the desired quantity of steam. The factor upon which the calculations are then based is the cost of converting a given quantity of water into steam, which can be obtained in the customary manner.

The measuring of the condensation water should be repeated for different sorts of warps, and notice taken of the time engaged in sizing and drying a certain length of warp. After obtaining these data it is possible to draw up a table, regarding different counts of yarns and different thicknesses, in such a way that the cost may be arrived at by taking the time occupied in the treatment of varying lots of warps. The consumption of steam is greatest during the first hours of working, because of the machine being cold at the start; but from the second hour to the tenth there is more equality.

In the sizing of large warps, running (say) for over five hours, it is necessary to work through meal hours.

In these instances it is very noticeable that a saving in steam is effected; whereas by a long interruption of the work (for example, during the dinner hour) there is relatively more steam used. The disadvantage of working-through may well in most mills be outweighed by the advantage of conforming to the regular meal hours. The balancing factor controlling the question is, of course, the cost of driving when the bulk of the machinery is at a standstill. When working-through is not permissible, the consumption of steam during the first hour is doubled. Again, the thicker the warp to be treated, the greater is the amount of steam consumed, and coarse counts require more steam to dry than do fine counts.

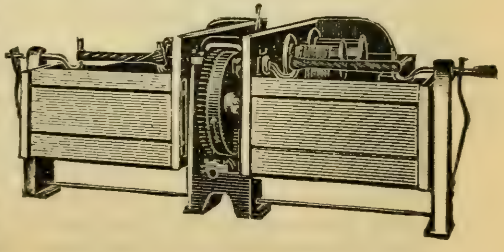
Based upon the foregoing considerations, the following figures are given as shewing the results of calculations made at a place where the cost of coal was somewhat high, but the cost of driving low on account of the use of water-power. The warp at the time was 30's counts 2,530 ends, with a width in the sheet form of 30 inches.

The first hour's running of the machine was estimated to cost 1.77 shillings; by the second hour 2.18; by the third 2.59; by the fourth 3.00; by the fifth 3.41; by the sixth 3.88; by the seventh 4.22; by the eighth 4.63; by the ninth 5.04; and by the end of the tenth hour the cost was 5.45 shillings. The length of the warp was 12,000 yards, and it occupied these ten hours in passing through the machine.

HANK SIZING.

Hank Sizing is chiefly adopted for bleached and coloured yarns. Machines are made single and double, and of the following types:—

Type 1.—Single machine, which consists of a beck to contain size, fitted with one or two revolving flanged rollers and two hooks. Knots of hanks are thrown on the rollers and thereby rotated with their lower ends in the size. When sufficient has been taken up, the hanks are removed and placed upon the hooks. One of these then gives a few turns, twisting up the hanks and wringing out excess



size, after which they are untwisted and taken off. Drying is performed by hanging the hanks upon poles in a stove.

Type 2.—Double machine having two becks, each fitted similarly to the one described above, and both driven from the same gearing. In the case of double sizing, the hanks are passed through one beck, wrung out, and again passed through the second beck, which contains thicker size than the first. By this process the saturation of the thread with thicker size is more complete.

Type 3.—In this the yarn is dealt with in 1 lb. knots, and placed on sticks resting on slowly travelling endless chains, which traverse each side of a long box containing the size. The yarn is washed about and turned over by boys in its progress from the back to the front of the machine. There it is placed on hooks carried in the two large discs secured to the centre shaft. During one revolution of the shaft the yarn is automatically stretched, wrung, and released.

Type 4.—In this the yarn is run quickly through the size by being placed on hexagonal copper rollers or winces, driven by ropes or belts from the lower shaft. The period of immersion is fixed by the speed of a large worm-driven wheel, which ingeniously wrings out the yarn by the hooks and pinions, releases it, and allows for a period of rest during which the yarn is taken off and replaced. This machine has a large productive capacity, and requires little labour.

Type 5.—This sizes and squeezes the yarn in a flat open condition, and is not so liable to damage the work as when wrung out by hooks having a definite movement without any provision for unequal length of hanks.

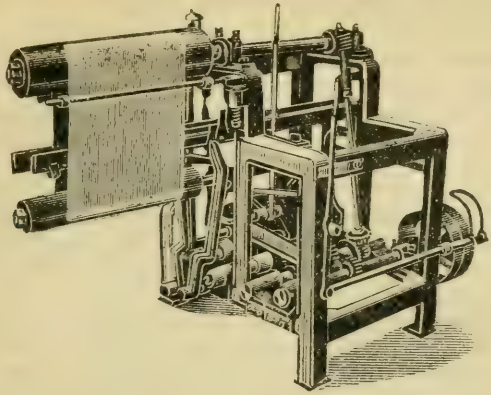
HANK STRETCHING, SHAKING, AND BRUSHING MACHINE.

Function.—To stretch and open the hank, break up sticky places and entanglements, and generally facilitate the process of winding.

Description.—Brushes the hanks by means of flat reciprocating brushes, operating on either side of the hank. The shaking and stretching are accomplished by a fulling roller, which can be regulated according to the counts and degree of stretching required. An indicator is fitted to the machine, which rings a bell when the hank has completed the one or more revolutions that may be necessary for sufficient brushing and stretching.

By removing the brushes, this same machine can be used for stretching and shaking only.

The machines are made to operate on one or two sets of hanks at a time.

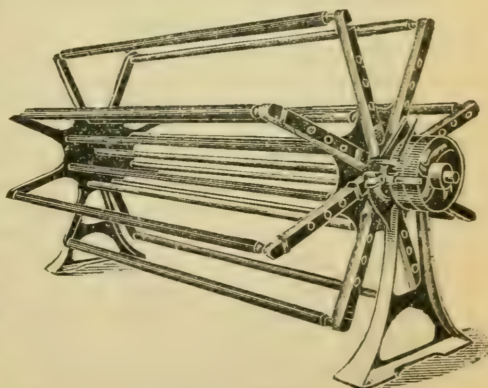


Floor Space.—3 ft. 6 in. × 5 ft. 10 in.

Another type of drying machine is described in Section VIII.

HANK DRYING MACHINE.

Function.—To dry yarn quickly, which has been sized or dyed in the hank. It takes the place of stoves and other systems in which heat is used. It is well adapted for tender yarns.



Description. — Consists of a swift composed of a series of bars similar to those of a reeling machine, with a corresponding number of rods arranged near the centre. One end of the hank is passed round the bar and the other over the rod. These bars and rods are loose, and the machine is furnished with two sets, so that one set can be in process of loading while the contents of the other are drying. To ensure the yarn being dried uniformly, the hanks are automatically traversed round the bars and rods.

Speed.—110 to 120 revs. per minute.
Production.—400 to 450 lb. in 10 hours.
Floor Space.—12 ft. 2 in. × 5 ft. 6 in.

TWISTING OR TYING-IN OF WARPS.—When the twisting-in is done by hand, the operator usually has his healds on the left and the new beam to which the ends have to be twisted on his right, stands being provided for carrying the beams. This operation, which is both slow and tedious, may now be done mechanically. A machine for the purpose, if properly manipulated, will tie on an average over 500,000 ends of 24's to 30's yarn per week, the attendance required being one skilled workman and an assistant.

The method adopted in the machine is to so clamp the old and the new warps as to hold them in two parallel sheets, supported in planes one above the other, the old warp or lease being uppermost. The mechanism of the machine then picks the individual threads from each sheet of warp and ties them together, instead of twisting them together, as is done when working by hand. When made, the knots are all of uniform size and the ends are cut off automatically and discharged into a suitable receptacle at the end of the machine. The principle is adaptable to a wide range of counts, varying widths of reeds, and a corresponding variation in the number of dents per inch of reed.

Another Machine.—To meet the demand of firms requiring a machine of smaller capacity, one is now made that will tie up to about 6,500 knots per hour, sufficient for (say) from 700 to 800 looms engaged in weaving prints or shirtings, and requiring the attention of one man only. While working on precisely the same lines as the one described above, this machine is arranged to take in sections of the warp instead of the whole width of the warp threads at a time. That is to say, in tying the threads of a 45-inch beam (for instance) there would be three series of operations of 15 inches each. Beam stands are provided similar to those of the large machine, but they are stationary, the truck upon which the tying mechanism is mounted being portable. While each section is being automatically tied, the attendant is free to finish the previously tied warp in the second beam-frame by getting the healds and reeds over, and to put into the empty frame a beam and fresh set of healds.

Tables giving Tin Roller-Wheels and Stud-Wheels for Various Lengths of Cuts.

Based upon a 45 bell-wheel and a measuring-roller of 14.4 inches circumference.

NOTE.—See foregoing examples (pp. 312-313) for method of ascertaining ratio wheels to mark off above lengths.

Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.
99	55	10	0.0	104	67	11	21.5	83	63	13	23.9
95	53	10	1.5	102	66	11	23.3	80	61	13	26.1
91	51	10	3.2	97	63	11	24.9	94	72	13	28.3
96	54	10	4.5	92	60	11	26.6	104	80	13	30.5
92	52	10	6.3	107	70	11	27.9	101	78	13	32.4
97	55	10	7.4	102	67	11	29.6	98	76	13	34.5
93	53	10	9.3	94	62	11	31.4	95	74	14	0.8
91	52	10	10.3	80	53	11	33.3	96	75	14	2.3
94	54	10	12.3	90	60	12	0.0	88	69	14	4.1
97	56	10	14.1	100	67	12	2.2	108	85	14	6.0
100	58	10	15.8	110	74	12	3.9	105	83	14	8.2
91	53	10	17.4	105	71	12	6.2	97	77	14	10.4
94	55	10	19.1	100	68	12	8.6	108	86	14	12.0
97	57	10	20.8	104	71	12	10.4	105	84	14	14.4
95	56	10	22.0	105	72	12	12.3	107	86	14	16.8
98	58	10	23.5	106	73	12	14.3	103	83	14	18.2
96	57	10	24.8	107	74	12	16.1	105	85	14	20.6
99	59	10	26.2	108	75	12	18.0	107	87	14	22.9
102	61	10	27.5	106	74	12	20.4	98	80	14	25.0
95	57	10	28.8	97	68	12	22.3	100	82	14	27.4
93	56	10	30.2	98	69	12	24.2	102	84	14	29.6
96	58	10	31.5	99	70	12	26.2	104	86	14	31.8
94	57	10	32.9	100	71	12	28.1	100	83	14	33.8
92	56	10	34.4	94	67	12	29.9	96	80	15	0.0
90	55	11	0.0	88	63	12	31.9	104	87	15	2.1
106	65	11	1.4	89	64	12	34.0	100	84	15	4.3
91	56	11	2.8	90	65	13	0.0	96	81	15	6.8
89	55	11	4.4	91	66	13	2.0	98	83	15	8.8
100	62	11	5.8	92	67	13	3.9	107	91	15	11.1
90	56	11	7.2	108	79	13	6.0	96	82	15	13.5
96	60	11	9.0	83	61	13	8.2	105	90	15	15.4
102	64	11	10.6	84	62	13	10.3	100	86	15	17.3
92	58	11	12.5	85	63	13	12.3	95	82	15	19.3
98	62	11	14.0	86	64	13	14.2	105	91	15	21.6
104	66	11	15.2	87	65	13	16.1	100	87	15	23.8
91	58	11	17.0	84	63	13	18.0	95	83	15	26.1
97	62	11	18.2	85	64	13	19.9	89	78	15	27.9
106	68	11	19.7	86	65	13	21.8	100	88	15	30.2

Tables giving Tin Roller-Wheels, &c.—Continued.

Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.
94	83	15	32.2	99	103	18	26.2	63	76	21	25.7
88	78	15	34.4	93	97	18	27.9	90	109	21	28.8
99	88	16	0.0	86	90	18	30.1	79	96	21	31.4
93	83	16	2.3	80	84	18	32.2	73	89	21	34.0
105	94	16	4.1	93	98	18	34.8	85	104	22	0.8
98	88	16	5.9	87	92	19	1.2	79	97	22	3.6
91	82	16	7.9	82	87	19	3.5	82	101	22	6.1
104	94	16	9.7	93	99	19	5.8	85	105	22	8.5
97	88	16	11.9	88	94	19	8.2	79	98	22	11.8
89	81	16	13.8	84	90	19	10.3	82	102	22	14.0
104	95	16	15.9	93	100	19	12.8	85	106	22	16.1
96	88	16	18.0	89	96	19	15.0	64	80	22	18.0
87	80	16	19.9	85	92	19	17.4	63	79	22	20.6
103	95	16	21.7	81	88	19	20.0	85	107	22	23.7
94	87	16	23.7	89	97	19	22.2	76	96	22	26.5
84	78	16	25.7	86	94	19	24.3	71	90	22	29.4
103	96	16	28.0	83	91	19	26.5	70	89	22	31.9
93	87	16	30.2	80	88	19	28.8	76	97	22	35.1
82	77	16	32.5	87	96	19	31.0	75	96	23	1.4
104	98	16	34.6	84	93	19	33.4	70	90	23	5.1
92	87	17	0.8	81	90	20	0.0	69	89	23	7.8
79	75	17	3.2	87	97	20	2.5	68	88	23	10.6
85	81	17	5.5	84	94	20	5.1	67	87	23	13.4
92	88	17	7.8	82	92	20	7.0	66	86	23	16.4
75	72	17	10.1	79	89	20	10.0	65	85	23	19.4
82	79	17	12.3	77	87	20	12.2	64	84	23	22.5
91	88	17	14.6	82	93	20	14.9	63	83	23	25.7
101	98	17	16.8	80	91	20	17.1	62	82	23	29.0
77	75	17	19.2	78	89	20	19.4	61	81	23	32.5
89	87	17	21.4	76	87	20	21.8	60	80	24	0.0
102	100	17	23.3	81	93	20	24.0	77	103	24	2.8
61	60	17	25.4	79	91	20	26.4	76	102	24	5.7
73	72	17	27.1	77	89	20	29.0	75	101	24	8.6
86	85	17	28.5	75	87	20	31.7	74	100	24	11.7
101	100	17	29.6	79	92	20	34.6	73	99	24	14.8
70	70	18	0.0	77	90	21	1.4	72	98	24	18.0
99	100	18	6.5	75	88	21	4.3	71	97	24	21.3
79	80	18	8.2	79	93	21	6.8	70	96	24	24.7
64	65	18	10.1	83	98	21	9.1	69	95	24	28.2
100	102	18	13.0	76	90	21	11.4	68	94	24	31.8
91	93	18	14.2	64	76	21	13.5	75	104	24	34.6
79	81	18	16.4	68	81	21	15.9	74	103	25	1.9
99	102	18	19.6	77	92	21	18.2	73	102	25	5.4
92	95	18	21.1	86	103	21	20.1	72	101	25	9.0
83	86	18	23.4	79	95	21	23.2	71	100	25	12.7

Tables giving Tin Roller-Wheels, &c.—Continued.

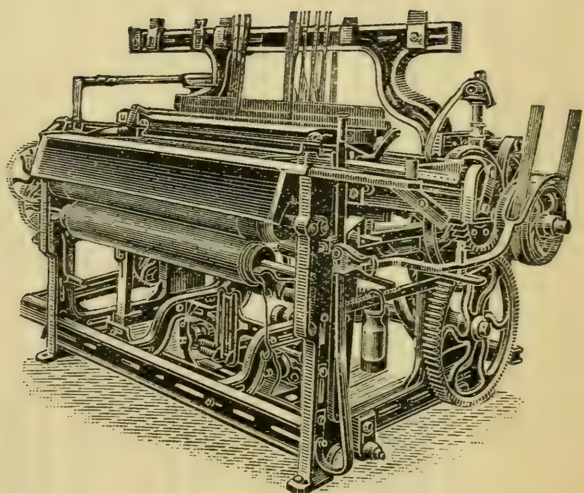
Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.
63	89	25	15.4	53	89	30	8.2	55	109	35	24.2
72	102	25	18.0	51	86	30	12.7	50	100	36	0.0
71	101	25	21.8	52	88	30	16.6	54	109	36	12.0
77	110	25	25.7	53	90	30	20.4	40	81	36	16 2
76	109	25	29.4	54	92	30	24.0	53	108	36	24.5
75	108	25	33.1	55	94	30	27.5	45	92	36	28.8
74	107	26	1.0	56	96	30	30.9	40	82	36	32.4
71	103	26	4.1	50	86	30	34.6	53	109	37	0.7
57	83	26	7.6	51	88	31	2.1	48	99	37	4.5
63	92	26	10.3	56	97	31	6.4	43	89	37	9.2
73	107	26	13.8	61	105	31	10.0	52	108	37	13.8
70	103	26	17.5	51	89	31	14.8	48	100	37	18.0
65	96	26	21.0	56	98	31	18.0	44	92	37	22.9
56	83	26	24.4	62	109	31	23.2	51	107	37	27.5
72	107	26	27.0	51	90	31	27.5	48	101	37	31.5
65	97	26	31.0	57	101	31	32.2	45	95	38	0.0
66	99	27	0.0	54	96	32	0.0	42	89	38	5.1
73	110	27	4.4	51	91	32	4.2	48	102	38	9.0
72	109	27	9.0	48	86	32	9.0	46	98	38	12.5
50	76	27	13.0	60	108	32	14.4	44	94	38	16.4
57	87	27	17.1	52	94	32	19.4	42	90	38	20.6
62	95	27	20.9	54	98	32	24.0	47	101	38	24.5
65	100	27	24.9	56	102	32	28.3	45	97	38	28.8
68	105	27	28.6	58	106	32	32.3	43	93	38	33.5
60	93	27	32.4	60	110	33	0.0	47	102	39	2.3
63	98	28	0.0	56	103	33	3.9	45	98	39	7.2
57	89	28	3.8	59	109	33	9.2	49	107	39	11.0
60	94	28	7.2	55	102	33	13.7	42	92	39	15.4
63	99	28	10.3	51	95	33	19.1	46	101	39	18.8
59	93	28	13.4	54	101	33	84.0	44	97	39	24.5
60	95	28	18.0	57	107	33	28.4	47	104	39	29.9
61	97	28	22.4	51	96	33	31.8	41	91	39	34.2
62	99	28	26.7	54	102	34	0.0	44	98	40	3.3
63	101	28	30.9	48	91	34	4.5	47	105	40	7.7
64	103	28	34.9	51	97	34	8.5	46	103	40	11.0
65	105	29	2.8	55	105	34	13.1	49	110	40	14.7
66	107	29	6.5	48	92	34	18.0	48	108	40	18.0
59	96	29	10.4	52	100	34	22.2	43	97	40	21.8
52	85	29	15.2	57	110	34	26.5	38	86	40	26.5
64	105	29	19.1	47	91	34	30.6	48	109	40	31.5
65	107	29	22.7	52	101	34	34.6	47	107	40	35.2
52	86	29	27.7	41	80	35	4.4	46	105	41	3.1
53	88	29	31.9	48	94	35	9.0	45	103	41	7.2
63	105	30	0.0	56	110	35	12.9	44	101	41	11.5
61	102	30	3.5	40	79	35	19 8	43	89	41	15.9

Tables giving Tin Roller-Wheels, &c.—Continued.

Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.
42	97	41	20.6	38	102	48	11.4	29	91	56	17.4
41	95	41	25.5	39	105	48	16.6	33	104	56	26.2
40	93	41	30.6	40	108	48	21.6	30	95	57	0.0
45	105	42	0.0	38	103	48	28.4	34	108	57	6.4
44	103	42	4.9	39	106	48	33.2	32	102	57	13.5
43	101	42	10.0	40	109	49	1.8	30	96	57	21.6
45	106	42	14.4	38	104	49	9.5	33	106	57	29.5
44	104	42	19.6	39	107	49	13.8	31	100	58	2.3
46	109	42	23.5	40	110	49	18.0	29	94	58	12.4
45	107	42	28.8	37	102	49	22.4	32	104	58	18.0
44	105	42	34.4	38	105	49	26.5	31	101	58	23.2
38	91	43	3.8	35	97	49	31.9	30	98	58	28.8
45	108	43	7.2	36	100	50	0.0	29	95	58	34.8
44	106	43	13.1	37	103	50	3.9	28	92	59	5.1
41	99	43	16.7	38	106	50	7.6	30	99	59	14.4
38	92	43	20.8	35	98	50	14.4	32	106	59	22.5
42	102	43	25.7	36	101	50	18.0	31	103	59	29.0
39	95	43	30.5	38	107	50	24.6	30	100	60	0.0
45	110	44	0.0	34	96	50	29.6	29	97	60	7.4
44	108	44	6.5	36	102	51	0.0	28	94	60	15.4
41	101	44	12.3	38	108	51	5.7	30	101	60	21.6
36	89	44	18.0	34	97	51	12.7	29	98	60	29.8
44	109	44	21.3	36	103	51	18.0	28	95	61	2.6
37	92	44	27.2	38	109	51	22.7	32	109	61	11.3
40	100	45	0.0	33	95	51	29.5	31	106	61	19.7
43	108	45	7.5	36	104	52	0.0	30	103	61	28.8
42	106	45	15.4	38	110	52	3.8	29	100	62	2.5
43	109	45	22.6	31	90	52	9.3	28	97	62	12.9
35	89	45	27.8	34	99	52	14.8	27	94	62	24.0
40	102	45	32.4	37	108	52	19.5	30	105	63	0.0
43	110	46	1.7	30	88	52	28.8	31	109	63	10.5
39	100	46	5.5	36	106	53	0.0	30	106	63	21 6
42	108	46	10.3	31	92	53	15.1	31	110	63	31.4
38	98	46	15.2	37	110	53	18.4	30	107	64	7.2
41	106	46	19.3	34	102	54	0.0	29	104	64	19.9
42	109	46	25.7	36	109	54	18.0	30	108	64	28.8
38	99	46	32.2	29	88	54	22.3	26	94	65	2.8
39	102	47	2.8	36	110	55	0.0	30	109	65	14.4
40	105	47	9.0	31	95	55	5.8	26	95	65	27.7
38	100	47	13.3	29	89	55	8.7	27	99	66	0.0
39	103	47	19.4	35	108	55	19.5	28	103	66	7.7
40	106	47	25.2	31	96	55	26.7	29	107	66	14.9
38	101	47	30.3	29	90	55	31.0	27	100	66	24.0
39	104	48	0.0	35	109	56	2.1	28	104	66	30.9
40	107	48	5.4	32	100	56	9.0	26	97	67	5.5

Tables giving Tin Roller-Wheels, &c.—Continued.

Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.	Tin Roller Wheel.	Stud Wheel.	Yards.	Inches.
31	116	67	13	23	105	82	6	18	104	104	0
28	105	67	18	24	110	82	18	18	105	105	0
27	102	68	0	18	83	83	0	18	106	106	0
24	91	68	9	16	74	83	9	18	107	107	0
21	80	68	21	14	65	83	21	18	108	108	0
22	84	68	26	23	107	83	27	18	109	109	0
24	92	69	0	15	70	84	0	18	110	110	0
14	54	69	15	25	117	84	9	18	111	111	0
16	62	69	27	18	85	85	0	18	112	112	0
27	105	70	0	19	90	85	9	18	113	113	0
29	113	70	5	20	95	85	18	15	95	114	0
29	114	70	27	18	86	86	0	18	115	115	0
18	71	71	0	23	110	86	3	18	116	116	0
24	95	71	9	24	115	86	9	16	104	117	0
27	107	71	12	21	101	86	21	16	105	118	4
14	56	72	0	24	116	87	0	16	106	119	9
27	109	72	24	19	92	87	6	15	100	120	0
24	97	72	27	16	78	87	27	16	107	120	13
18	73	73	0	18	88	88	0	16	108	121	18
27	110	73	12	21	103	88	10	16	109	122	22
24	98	73	18	18	89	89	0	16	110	123	27
27	111	74	0	21	104	89	5	16	111	124	31
25	103	74	6	23	114	89	8	16	112	126	0
24	99	74	9	14	70	90	0	16	113	127	4
24	100	75	0	16	80	90	0	16	114	128	9
17	71	75	6	18	91	91	0	16	115	129	13
27	113	75	12	15	76	91	7	16	116	130	18
24	101	75	27	21	107	91	26	14	102	131	5
18	76	76	0	18	92	92	0	15	110	132	0
25	106	76	12	16	82	92	9	15	111	133	7
20	85	76	18	14	72	92	21	15	112	134	14
18	77	77	0	18	93	93	0	14	105	135	0
24	103	77	9	21	109	93	15	14	106	136	10
27	116	77	12	18	94	94	0	14	107	137	21
25	108	77	27	20	105	94	18	15	115	138	0
15	65	78	0	18	95	95	0	15	116	139	7
23	100	78	9	14	74	95	5	14	109	140	5
16	70	78	27	15	80	96	0	14	110	141	15
18	79	79	0	18	97	97	0	14	111	142	26
24	106	79	18	18	98	98	0	14	112	143	1
18	80	80	0	14	77	99	0	14	113	145	10
24	107	80	9	18	100	100	0	14	114	146	21
14	63	81	0	18	101	101	0	14	115	147	31
24	109	81	27	18	102	102	0	14	116	149	5
18	82	82	0	18	103	103	0	14	117	150	15



Plain Calico Loom.

SECTION VII:

WEAVING

PLAIN AND JACQUARD LOOMS

PRINCIPAL WEAVES

ETC.

WEAVING:

THE POWER LOOM.

Function.—Forms a fabric by interlacing warp and weft threads.

Construction.—Contains parts for the performance of three essential movements, namely: shedding, picking, and beating up; for controlling the tension and delivery of the warp; for taking up the cloth as it is produced; and for arresting its motion in the event of failure or breakage of the weft, or of the shuttle becoming trapped in the warp.

SHEDDING is the operation of dividing the warp into two portions for the insertion of the weft. In the case of small patterns it is performed by healds, controlled by tappets or dobby machines; in larger patterns by harness threads controlled by a jacquard machine.

PICKING is the operation of passing the shuttle containing weft through the opening formed in the warp by the shedding motion.

BEATING-UP—*i.e.*, placing the weft threads in line with one another—is performed by the reed and sley, which, through the action of the cranks and connecting rods, are caused to advance towards and recede from the cloth after each passage of the shuttle and weft.

Other details of the loom must be varied in accordance with the particular kind of cloth to be woven, and the variety is too great to admit of description here. It may, however, be said that for the simpler kinds of cloths, such as plains, twills, sateens, etc., **shedding** is controlled by **rotary tappets** contained within the loom framing, as these admit of high speeds being attained. The usual capacity of such motions is five or six-shaft and as many picks to the round. For patterns of larger repeat (say up to eight or ten shafts and sixteen picks to the round) or when frequent changes of the pattern are required, tappets of the box-plate and Woodcroft types are used.

Within recent years the **oscillating tappet** has made considerable advances, and is now extensively used for patterns of larger repeat, especially as regards the number of picks to the round, in which direction there is practically no limit to its capacity. The feature of this tappet is that it oscillates upon a shaft, and pushes up, or pulls down, treadles which transfer a similar but

opposite motion to the heald shafts. The selection of shafts to be lifted or depressed is effected by two chains of spindles—one for odd picks of the pattern, and the other for even picks—which carry collars and bowls, *i.e.*, rollers of small and large diameter, that act upon levers to determine the position of swivelling pieces with regard to the treadle bowls. The motion is positive in its action upon the heald shafts, and is therefore well suited for heavy goods, in which such an action is necessary on account of the tension upon the warp.

Picking Motions are classed as Over Picks and Under Picks. In the former the shuttle receives motion from a point above the sley, and in the latter case from a point beneath. The Over Pick is generally applied to fast-running looms, as the movement of the shuttle is more gradually developed and a smoother pick results. Strong and heavy fabrics and wide looms have the Under Picking motion, which can give a stronger blow to the shuttle. It is also cleaner, as oil is not required about its parts near the cloth; it is therefore more suitable for bleached and coloured goods.

High-speed looms weaving light and medium weight cloths have loose reeds, slow looms and heavy cloths have fast reeds.

The majority of looms are fitted with taking-up motions of the positive type. These consist of a train of wheels, of which the first is a ratchet wheel, actuated by a pawl from the sley, and transferring motion to a beam or roller whose roughened surface draws the cloth forward.

Letting-off is effected in nearly all light looms by the chain or rope-and-collar friction arrangement, so that the taking-up motion *draws-off* just the amount of warp required. In heavy looms, friction letting-off motions, which act similarly to the chain-and-collar, or the positive letting-off motion in which the tension of the warp regulates the letting-off, are most largely in use. This latter motion necessitates the adjustment of weights, and the nice regulation of the positive drive from the going-part.

Of the accessory motions of the loom the most important are—the weft-fork mechanism; the shuttle stop-rod motion or the loose-reed motion, for stopping the loom without breakage of the warp should the shuttle stop in the shed; and the warp-stop motion, which stops the loom should any end break down. The value of the last-

named motion has long been questioned, but it is making such rapid headway that it claims notice here.

Pulleys.—8 in. to 10 in. dia.

Floor Space.—40 in. loom............6 ft. 10 in. × 4 ft. 1 in. Add inches in reed space for other sizes of looms.

Power.—One Plain Loom = .16 I.H.P.

Production.—Fifty-inch Plain Loom: About 32 lb. twist and weft per loom per 56½ hours.

Picker Spindle Lubricator.—Applies the necessary amount of lubricant to the picker spindle of an over-pick loom automatically, and ensures freedom to the picker and minimises wear and tear. The device consists of a small pad saturated with oil, which is carried by an arm secured to the back-board of the loom. At each forward movement of the sley the pad deposits a very small quantity of oil, and on the return movement recedes from the spindle to give clearance for the passage of the picker. (Patented.)

Centre Selvedge Motions.—Are required when weaving two widths of cloth in one loom, to produce the necessary selvedges at the sides where the cloth is divided. Devices for this purpose are supplied by the principal loom makers.

Loom Stop and Take-up Motion.—This is an auxiliary device for preventing the crowding together of weft threads when a loom is stopped by drawing forward the fork-holder, not by the failure of the weft thread.

The fork-holder is detached from the knocking-off lever, and is supported upon a pivot having the same centre of turn as the weft hammers. When drawn forward by the hammer, the holder comes into contact with a lever attached to the ordinary catch-rod of the loom, and the catches are lifted out of the ratchet-wheel which forms part of the take-up gear. At the same time another part of the fork-holder abuts against a stud-plate mounted on the end of the knocking-off lever, whereupon the loom is stopped in the usual way.

Speeds of Looms.

The following may be given as approximate speeds, but it will be understood that considerable variations are made therefrom, according to pattern or structure of cloth, counts, and quality of material, size of shuttle, weight of cloth, etc :—

40 in. reed space, plain loom, loose reed,	220 to 230	picks per min.
„ „ „ fast „	190 to 200	„
„ „ drop-box „	160 to 170	„
„ „ circular „	170 to 180	„
„ „ single-lift jacquard	120 to 130	„
„ „ double-lift „	160 to 180	„
„ „ single-lift dobby	130 to 140	„
„ „ double-lift „	180 to 200	„

Speed Counters are now available for registering the number of picks made on a loom. They are usually placed on the floor, at the side of the loom, and are driven from the tappet shaft.

RULES.

To calculate the speed of a loom—

Multiply the drum on the line shaft by its number of revolutions per minute, and divide by the loom pulley.

To find the loom pulley to produce a given loom speed—

Multiply line shaft drum by its revolution and divide by the picks wanted.

It is necessary to allow for slipping of the belt to find the actual loom speed; 8 to 10 per cent. will generally cover this.

To calculate the production of a loom—

$$\frac{\text{Picks per minute} \times 60 \times \text{hour's run}}{\text{Picks per inch} \times 36} = \text{Yards of Cloth.}$$

From this allowance must be made for stoppages of the loom for changing shuttles, piecing warp threads, etc. This will vary from 10 to 40 per cent., according to circumstances of count of weft, size of shuttle, style of fabric, quality of material, but 10 per cent. will cover the loss in the ordinary run of plain goods.

Taking-up Motions.

The following are trains of wheels or "gears" in common use:—

Rack or Ratchet Wheel.	Beam Wheel.	Stud or Carrier Wheel.	Carrier Pinion.	Circumference of Beam.	Dividend.
50	75	120	15	15 in.	507
60	60	100	12	15 „	507
50	75	100	12	15 „	528
60	75	120	15	15 „	609
60	75	100	12	15 „	634
50	90	146	14	15 „	794

Rule.—To find picks per inch from any gear—

$$\frac{\text{Beam Wheel} \times \text{Carrier Wheel} \times \text{Rack Wheel}}{\text{Carrier Pinion} \times \text{Cir. of Beam} \times \text{Change Pinion}} = \text{Picks per inch.}$$

Rule.—To find change pinion—

$$\frac{\text{Beam Wheel} \times \text{Carrier Wheel} \times \text{Rack Wheel}}{\text{Carrier Pinion} \times \text{Cir. of Beam} \times \text{Picks per inch}} = \text{Change Pinion.}$$

If picks per ¼ inch are wanted the circumference of the beam must be in quarter inches.

The foregoing formulæ assume one tooth of the rack wheel to be taken up for each pick. If two teeth are moved each pick, divide by 2.

To save the necessity for calculating wheels for each change of picks by the above formula it is usual to find the "Dividend" of the gear. This is a number constituting the product of the picks per inch or per ¼ inch, and the number of teeth in the change wheel necessary to produce them. Hence if the dividend be divided by a change wheel the result is the number of picks produced, while if it be divided by number of picks the necessary change wheel is obtained.

Rule.—To find the dividend of a gear—

$$\frac{\text{Beam Wheel} \times \text{Stud Wheel} \times \text{Rack Wheel}}{\text{Cir. of Beam} \times \text{Carrier Pinion}} = \text{Mathematical Dividend.}$$

It is customary to add 1½ per cent. to the mathematical dividend to allow for the contraction that takes place after the cloth is removed from the loom. This gives the practical dividend. The dividend, for picks per ¼ inch, of the first-mentioned gear in the above table is—

$$\frac{75 \times 120 \times 50}{60 \times 15} = 500 \text{ Mathematical Dividend.}$$

7½ 1½ per cent. added for contraction.

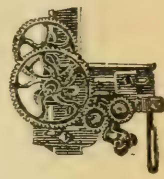
507½, say 507 Practical Dividend.

With the foregoing mentioned gears, particularly those having the smaller dividends, there is often a difficulty in obtaining an exact number of picks per ¼ inch; also the fact that a smaller pinion gives a greater number of picks, and vice versâ, frequently results in errors. Therefore 7-wheel gears are now used. Of these the "Pickles" gear is an example. It consists of a rack wheel of 24 teeth. Upon the same stud is a "standard" wheel of 36 teeth, gearing into the change wheel. Upon the same stud as the latter is a "swing" pinion of 24

that drives a carrier of 89, with which is compounded a pinion of 15, driving the beam wheel of 90 teeth. The beam is 15.05 inches circumference. With this arrangement the number of picks per inch corresponds exactly with the number of teeth in the change pinion. The standard wheel also can be changed. Thus, when the latter has 27 teeth, every tooth of the change wheel is equal to 1⅓ picks per inch; with 18 standard one tooth of the change wheel is equal to 2 picks, and with 9 standard to 4 picks.

Taking-up Releasing Motion.

Function.—To prevent weak or thin places in the cloth caused by failure in the weft after the loom has been stopped, and to relieve the weaver of responsibility in having to run back the taking-up motion on these occasions.



Description.—Is an attachment worked in conjunction with the ordinary taking-up motion, consisting of a toothed quadrant gearing into the teeth of the ordinary ratchet-wheel. When a weft thread breaks, the action of the weft lever in lifting the holding-back catch (and with it the taking-up catch) out of gear, puts into operation the quadrant which for the time being controls the ratchet wheel and allows it to let back the warp the distance required to make up the deficiency caused by the stoppage of the loom—which may be one to two or more picks, according to the class of fabric woven. On restarting the loom, the holding-back and the taking-up catches fall into gear with the ratchet wheel again, and the taking-up proceeds as before.

Reed Relief Motion.—For preventing the breakage of warp threads when the shuttle fails to get home in one or other of the boxes in the sley of a fast-reed loom. Consists in the application of mechanism combining the present loose and fast reed systems, whereby the manufacturer is enabled to take advantage of the merits of both. That is to say, the reed is automatically released when the shuttle is not in the box, but it is rigidly fixed while the loom is working smoothly. The invention dispenses with the "duck-bills" and "frogs" and attachments connected therewith, which are objectionable because of the severe strain they put upon the frame of the loom by the impact necessary to stop the loom.

Wire Healds.—By the introduction of tempered cast-steel wire the weight of these healds has been greatly reduced and their strength increased, so that they can now be used in the weaving of fine fabrics. They are manufactured in the following forms:—

(1) With the healds mounted upon light flat steel rods having rounded edges and the healds made $\frac{1}{8}$th-inch longer than the distance over the rods, to allow free movement for the weaver to pass the hand through to tie up broken threads, etc.

(2) As a combination of knitted and wire healds, in which case the rods are dispensed with and the healds are carried by cotton loops, which are knitted to the required pitch as in ordinary healds.

(3) Mounted in a heavy birch-wood frame—with double rods when these are required for use in weaving carpets, sail-cloth, belting, and similar heavy goods.

Expanding Yarn Beams.—For use in weaving towels, terry, and similar fabrics. They dispense with wedges and the wooden roller upon which the flanged tube is mounted, and provide in their place a centre support, capable of having its diameter increased so as to fit tightly inside the tube. This centre piece consists of a shaft upon which are free to slide two conical bushes, carrying three longitudinal bars for supporting the tube. Against the bushes are secured two nuts, which work on two screwed portions of the shaft. As these nuts are turned in either direction, the supports are moved towards or from the middle of the beam; and as their positions are changed the diameter of the bars is altered accordingly.

Strapping-up Looms.—An ordinary Over-pick Loom takes—

2 Picking bands.	1 Check strap.
2 Tuggers.	2 Pickers.
2 Tugger straps.	2 Picker straps.

Total cost, about 8s. 6d. to 10s. per loom.

A Northrop Loom takes—

2 Pieces 18 in. × 2 in. each for check straps.
2 Butt straps 10 in. × 1 in.
4 Heald roller straps 15 in. × 1 in.

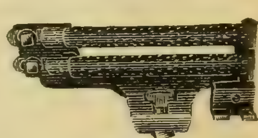
To each of the above add about 22 feet of 2 in. belting for transmitting power from line shaft to loom.

Leather Buffer Springs.—For prolonging the life of pickers and picking bands. The spring is made in the

form of two U-shaped sections of leather, fastened together securely at the top or open end. The inner section is arranged to be close up to the spindle, so that when in operation it duplicates the springing action. Made in different forms, to suit different kinds of looms.

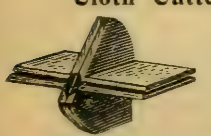
Self-Adjusting Loom Swells.—The swell slides with the shuttle as the latter enters the box, and in so doing causes a roller to run along an incline on the back-plate. This back-plate is kept up to its work by a double bow-spring, which imparts to the swell proper the steady but gentle pressure necessary to arrest the shuttle on the completion of a pick. On the return journey the impact of the picker against the shuttle and the contact of the shuttle with the swell cause the latter to return to its original position and the roller to run back along the incline, thereby releasing the pressure from the shuttle side.

Loom Temples.—There are three recognised types of temples used on ordinary cotton looms, namely—(1) The "trough and roller"; (2) the "two roller" side temple; and (3) the "ring" or expanding side temple. Of these the first-named are specially suited to the weaving of dooties and similar fabrics, while both the latter are adapted for stronger cloth, such as will stand more side pull in the process of weaving.

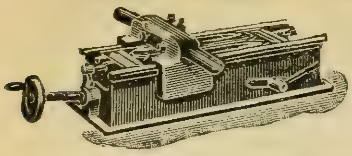


By a recent improvement effected in the construction of these temples it is made possible to bring out the width of the cloth in the loom to within ½ inch of the full reed-space. That is to say, it is possible to gain ⅜ths of an inch on either side, thus making a total increase of ¾ths of an inch available over the side temples hitherto used.

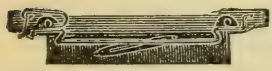
Cloth Cutter.—For use in cutting the cloth while in the loom when weaving "split-ups." The cutter is not fixed to any part of the loom, but rides on the woven fabric close up against the loom breast-beam. It is made of aluminium, and is very light. The cutting blade used is similar to that of a safety razor, and can be applied in four different places.



Shuttle Trimmer.—For truing the faces of worn shuttles. Consists of a cast-iron framework, capable of receiving a pair of shuttles at a time. The upper surface of the framework is planed to receive a sliding cutter, which as it is moved backward and forward pares away a thin layer of the wood, leaving the shuttle with a smooth surface. The trimmer can be fixed to a bench, and provision is made for ensuring the proper angle to the shuttle while in the casing.



Shuttle Guards.—To prevent shuttles flying out from looms during the process of weaving. Are fixed on the hand-rail of the loom, directly over the shuttle race. Usually consist of a bow spring, secured at one end to a bracket, which carries a guard-rod extending across the loom. The opposite end of the bow spring is carried over and formed into a loop to receive one end of a link. This link connects the spring to the guard-rod by passing underneath a hooked projection formed on the rod.



Guards constructed on this principle are always operative when the loom is at work, and can be readily pushed out of the way to allow the weaver to attend to any duty connected with this part of the machine.

A Safety Weft Hammer.—A preventive against injury to operatives by the trapping of the fingers when accidentally getting in the path of the hammer. Is constructed with its head in two portions, one of which is pivotally mounted—so that, while normally adapted to fulfil its usual function, it yields to slight pressure from any obstruction from below.

HAND-THREADING SHUTTLES.

The possible ill-effects arising from the insanitary practice of "kissing" or sucking the shuttle in order to thread the weft through the eye has led to the invention of various devices intended to dispense with the necessity of the practice.

The chief points to be observed in selecting a shuttle-threader are:—(1) The weaver must not be inconvenienced by its use. (2) The appliance, if fixed in the shuttle, must be able to withstand, without coming loose, the rapid reciprocating motion of the shuttle across the loom. (3) The shuttle must not be weakened by the

application of the device. (4) It should not be possible for the weaver to resort to the old practice of sucking the thread through the shuttle eye by applying the mouth. (5) The appliance must not be costly to adopt.

Some Devices Available.

(I.) In which a bent metal plate is inserted near the outlet for the weft, which serves as a guide to direct the thread to the outside of the shuttle eye. The shuttle is held in one hand and the loose end of the weft in the other; then, by guiding the thread with the thumb of the hand holding the shuttle, it passes under the guide and slides down a projection to the outside of the shuttle, to be drawn away by the finger and thumb.

(II.)—In which a portion of the wood of which the shuttle is made is allowed to remain in the form of a peg extending obliquely, and the eye of the shuttle is made with a small additional loop. The threading is carried out by passing the weft round the peg, then pulling the thread towards the cop. The thread then presents itself across the eye, and is drawn out by the finger and thumb.

(III.)—In which the ordinary shuttle is used, and a small hook is inserted into the shuttle, the thread being drawn through the eye of the shuttle.

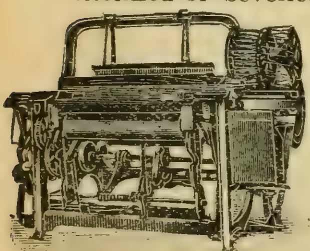
(IV.)—In which a loop of twisted twine is passed through the eye of the shuttle and through an additional eye formed in the shuttle beyond the peg. When threading, the weft is entangled with the loop, and by drawing the latter round, the weft is brought along with it to the outside of the shuttle.

(V.)—In which two holes, sufficiently large to admit of the insertion of the weaver's finger, are bored in the shuttle at right angles to each other. One of the holes is in line with the ordinary shuttle-eye, and the other is made from the top. When threading, the operative takes the end of the weft and inserts it into the vertical hole with the first finger of the right hand. The thread is then pushed forward to the shuttle-eye by the fourth finger of the left hand, from which point it is drawn away.

(VI.)—In which the thread from the cop is carried forward through a slit in the centre of the shuttle and behind an inclined plate, then brought back quickly. This action brings the thread out through the side of the shuttle, and by drawing the finger over the edge of the plate the thread is caught and the shuttle threaded.

Weft Detector Shuttle.—In cotton mills where the weft used in the shuttle is sometimes spun weft way and sometimes twist way, it sometimes happens that in the weaving shed the cops get mixed, with the result that both are unintentionally woven into the fabric when one kind only should be used. When this happens it is no easy task to detect the error: in fact its discovery is only possible after the cloth has been taken to the warehouse and is being examined by the clothlooker. Even then, too, it may escape notice if the examiner should fail to view the cloth side-ways, or if he should examine it by a side light shining on the fabric; but if such a cloth be passed on unnoticed to the bleacher or finisher, the fault will almost certainly bring complaints from the buyers and merchants, out of which various disputes may arise.

These mischances may be prevented by using a shuttle formed with a wooden projection near the inner wall towards the forward end, which may be on either side of the shuttle-peg, according to whether the shuttle is for twist-way or weft-way weft. Should a weft-way cop be inserted by mistake into a twist-way shuttle, the thread in winding off comes into contact with the upper thickened portion of the projection—and is thereupon immediately broken and the weaving cannot proceed. On the other hand, if a twist-way cop be inserted into a weft-way shuttle, the result is precisely the same. Alternatively, if the correct cop be inserted, the thread in unwinding comes into contact with the lower portion of the projection first, and travels easily up to an inclined or bevelled face, and thus no breakage occurs.



NORTHROP LOOM.

Function.—Same as the ordinary power-loom.

Description. — This loom possesses, in addition to the shedding, picking, and beating-up mechanisms of the power-loom, a battery, warp stop-motion, feeler and thread cutting motion, and warp let-off motion.

THE BATTERY holds 25 weft bobbins or cops, and places same in the shuttle when weft breaks or runs out.

Fabrics woven on Northrop looms are of two classes, which are distinguished as "feeler" and "non-feeler" cloth. The former includes all material in which every

pick must be present, and in which a double or half-pick would constitute a serious defect—such as sateens, flannelettes, unions, and dobby and certain jacquard weaves. "Non-feeler" cloth denotes ordinary calico, and such material as is not affected by double or half-picks.

FEELER AND THREAD CUTTING MOTION.—The first controls the weft in the shuttles and compels a fresh supply to be inserted before running out; the second is to cut and take care of the loose end of weft from the selvedge to battery end: these two combined ensuring perfect cloth.

THE WARP STOP MOTION controls the warp threads and stops the loom immediately a thread breaks.

THE WARP LET-OFF MOTION controls the letting-off of the warp from the beam automatically.

Speeds.—40 in. reed space loom, 175 to 200 picks per min.

Pulleys.—12 in. diameter.

Floor Space.—40 in. reed space loom, using 8 in. bobbin and 18 in. diameter beam flanges = 7 ft. 2 in. × 4 ft. 2 in.

Power.—Averaged on a shed of 500 looms, the same power as the ordinary loom.

Production.—Same as the ordinary loom, but the weaver attends to from 12 to 24 looms, according to cloth being produced.

Northrop Loom Wages.

The following is the text of the Agreement made on June 30th, 1907, between Messrs. Ashton Bros., of Hyde, and the officials of the Weavers' Amalgamation, regarding the payment of wages to the weavers engaged at the firm's mills in minding Northrop automatic looms:—

1. That the wage shall be based on 0.77 for 20,000 picks, 36 in. cloth.

2. That no objection shall be taken to speeding up the looms above the present speeds.

3. That the number of looms to be worked by any employee is not to be limited, provided employer and employee agree upon the number to be worked by such employee.

4. That the above covers up to and including 56 reeds; reeds above 56 to have 0.00834 for 20,000 picks added for

(Continued on page 340.)

Table of Change Wheels required for giving the Number of Picks per Quarter Inch, with the following Taking-up Motions and Dividends:—

DIVIDEND 507.

Rack wheel .... 50 Beam wheel 75
Stud wheel .... 120 Little pinion wheel 15
Circumference of Emery Beam...... 15 inches

Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.
14—36.214	32—15.844	50—10.14	68—7.456
15—33.8	33—15.364	51— 9.941	69—7.348
16—31.688	34—14.912	52— 9.75	70—7.243
17—29.824	35—14.486	53— 9.566	71—7.141
18—28.167	36—14.083	54— 9.389	72—7.042
19—26.684	37—13.703	55— 9.218	73—6.945
20—25.35	38—13.342	56— 9.054	74—6.851
21—24.143	39—13.	57— 8.895	75—6.76
22—23.045	40—12.675	58— 8.741	76—6.671
23—22.043	41—12.366	59— 8.593	77—6.584
24—21.125	42—12.071	60— 8.45	78—6.5
25—20.28	43—11.791	61— 8.311	79—6.418
26—19.5	44—11.523	62— 8.177	80—6.338
27—18.778	45—11.267	63— 8.048	81—6.259
28—18.107	46—11.022	64— 7.922	82—6.183
29—17.483	47—10.787	65— 7.8	83—6.108
30—16.9	48—10.563	66— 7.682	84—6.036
31—16.355	49—10.347	67— 7.567	85—5.965

DIVIDEND 609.

Rack wheel.......................... 60 Beam wheel 75
Stud wheel .... 120 Little pinion wheel 15
Circumference of Emery Beam...... 15 inches

Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch.
16—38.062	34—17.912	52—11.712	70—8.7
17—35.824	35—17.4	53—11.491	71—8.577
18—33.833	36—16.917	54—11.278	72—8.458
19—32.053	37—16.459	55—11.073	73—8.342
20—30.45	38—16.026	56—10.875	74—8.23
21—29.	39—15.615	57—10.684	75—8.12
22—27.682	40—15.225	58—10.5	76—8.013
23—26.478	41—14.854	59—10.322	77—7.909
24—25.375	42—14.5	60—10.15	78—7.808
25—24.36	43—14.163	61— 9.984	79—7.709
26—23.423	44—13.841	62— 9.823	80—7.612
27—22.556	45—13.533	63— 9.667	81—7.519
28—21.75	46—13.239	64— 9.516	82—7.427
29—21.	47—12.957	65— 9.369	83—7.337
30—20.3	48—12.687	66— 9.227	84—7.25
31—19.645	49—12.429	67— 9.09	85—7.165
32—19.031	50—12.18	68— 8.956	86—7.081
33—18.455	51—11.941	69— 8.826	87—7.

Table of Change Wheels.—*Continued.*

DIVIDEND 528.

Rack wheel .... 50 Beam wheel 75
Stud wheel .... 100 Little pinion wheel...... 12
Circumference of Emery Beam...... 15 inches

Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch	Wheel. Picks per ¼ inch	Wheel. Picks per ¼ inch.
14—37.714	32—16.5	50—10.56	68—7.765
15—35.2	33—16.	51—10.353	69—7.652
16—33.	34—15.529	52—10.154	70—7.543
17—31.059	35—15.086	53— 9.962	71—7.437
18—29.333	36—14.667	54— 9.778	72—7.333
19—27.789	37—14.27	55— 9.6	73—7.233
20—26.4	38—13.895	56— 9.429	74—7.135
21—25.143	39—13.538	57— 9.263	75—7.04
22—24.	40—13.2	58— 9.103	76—6.947
23—22.957	41—12.878	59— 8.949	77—6.857
24—22.	42—12.571	60— 8.8	78—6.769
25—21.12	43—12.279	61— 8.656	79—6.684
26—20.308	44—12.	62— 8.516	80—6.6
27—19.556	45—11.733	63— 8.381	81—6.519
28—18.857	46—11.478	64— 8.25	82—6.439
29—18.207	47—11.234	65— 8.123	83—6.361
30—17.6	48—11.	66— 8.	84—6.286
31—17.032	49—10.776	67— 7.881	85—6.212

DIVIDEND 634.

Rack wheel...................... 60 Beam wheel 75
Stud wheel .... 100 **Little pinion wheel** 12
Circumference of Emery Beam...... 15 inches

Wheel Picks per ¼ inch.	Wheel. Picks per ¼ inch.	Wheel. Picks per ¼ inch	Wheel. Picks per ¼ inch.
16—39.625	34—18.647	52—12.192	70—9.057
17—37.294	35—18.114	53—11.962	71—8.93
18—35.222	36—17.611	54—11.741	72—8.806
19—33.368	37—17.135	55—11.527	73—8.685
20—31.7	38—16.684	56—11.321	74—8.568
21—30.19	39—16.256	57—11.123	75—8.453
22—28.818	40—15.85	58—10.931	76—8.342
23—27.565	41—15.463	59—10.746	77—8.234
24—26.417	42—15.095	60—10.567	78—8.128
25—25.36	43—14.744	61—10.393	79—8.025
26—24.385	44—14.409	62—10.226	80—7.925
27—23.481	45—14.089	63—10.063	81—7.827
28—22.643	46—13.783	64— 9.906	82—7.732
29—21.862	47—13.489	65— 9.754	83—7.639
30—21.133	48—13.208	66— 9.606	84—7.548
31—20.452	49—12.939	67— 9.463	85—7.459
32—19.813	50—12.68	68— 9.324	86—7.372
33—19.212	51—12.431	69— 9.188	87—7.287

every two counts up to and including 60's; above 60's 0.01416 for every two counts up.

5. The prices for 32 in. and 40 in. cloth to be worked out to give a like wage; 32 in. loom running 176 picks, 40 in. 160 picks.

6. 64 in. cloth to be paid 1.5d. for 20,000 picks.

ACCESSORIES REQUISITE FOR 100 LOOMS
And Preparation Machinery.

For Sectional Warping Machine.

30 Solid Section Blocks, non-expanding.

For Beaming Machine.

30 gross Warpers' and Winders' Bobbins; inch lift, with metal binders.
6 gross Drop Pins.
600 Creel Pegs.
18 Warpers' Beams, with 21 inch cast-iron flanges

For Winding Frames.

12 Winders' and Warpers' Bobbin Skips, or Cans.
Some Winders' Flannel, for renewals.

For Pirn Winding Frame.

1 doz. Ryces.
50 gross Wood Pirns
12 lb. Cotton Banding.

For Slasher Sizing Machine.

100 yards Sizing Flannel.
1 Sizers' Copper Bucket.
1 Sizer's Brush.
1 Set of Change-wheels.
2 Leasing Combs.
1 Copper Washing-down Can.
1 Set of Twaddell Hydrometers (3 in set).
3 Striking Wraithes (suited to Counts).
3 Sets Friction Flannel Rings.
1 Trough for Washing Flannels, with Plug and Chain.
1 Pair Rubber Covered Wringing Rollers, with Handle

For Looming and Twisting Frames.

1 Loomer's Drawing Hook.
1 Slaying Chip.
14 Striking Combs and Caps
Proportionating for different widths of looms.
2 Twister's Hooks.

For Looms, Etc.

34 Spare Wood Yarn Beams, with cast-iron flanges and separate ruffles, proportioned for widths of looms.
200 lb. Chrome Picking Bands.
24 lb. Heald Cord.

4 gross pairs Buffalo Pickers.
2 Sets Tackler's Tools, each set containing:
 1 Large Hammer; 1 Small Hammer; 1 Brace, with 6 Bits—namely, 7/16 in., 3/8 in., 5/16 in., 1/4 in., 3/16 in., 1/8 in.; 1 Tenon Saw, 10 in. blade; 1 pair Spring Punches, with 3 Bits; 1 Pair Wire Cutters; 1 Pair Reed Plyers; 1 Tackler's Knife; 1 12 in. Steel Rule; 1 Picker Gouge; 1 Set Tackler's Spanners; 1½ in. x 1 in., 7/8 in. x 3/4 in., 3/4 in. x ½ in., 3/4 in. x ½ in., and 1 Pricker
2 Bench Vices.
50 Oil Cans, with Patent Adjustable Flow.
4 gross Belt Fasteners.
50 Waste Tins for Weavers.
50 Weft Tins.
600 Best Quy Shuttles, with Clips for Pirns.
100 Sets Prepared Small Strapping for Looms, proportioned for:—Plain, 3 and 4 Shaft, and More Shafts, and Box Looms.
50 Weaver's Reed Hooks.
50 Weaver's Scissors.
50 Weaver's Nippers.
60 Weft Forks.
24 Weft Fork Holders.
200 Change Pinion Wheels (assorted).
½ gross Picking Sticks.
2 Tappet Shaft Nut Keys.
2 Box Keys.
100 Pairs Shed Lease Rods (assorted lengths).
1 Galvanised Picker Steeper, with Bar, and Hooks.
2 gross Strap Laces.
1 Platform Weighing Scale; 4 cwts., for weighing Warp Beams.
1 Beam Scale, with weights.
1 Oil Cistern, and Stand, with Perforated Drippers.
50 Hand Brushes, for weavers.
25 Large Bristle Sweeping Brushes.
600 lb. Loom Strapping.
40 lb. 2 in. Belting, for Machines.
15 lb. 2½ in. ditto.
Reeds.
Healds.
Heald Staves.
Heald Yarn, Varnished, and Natural.
1 doz. Weft Fork Grates.
100 feet Steel Strip, for Take-up Rollers.
1 doz. Bow Springs.
400 Cork Screws for Loom Feet.
Spiral, and Flat Springs.
Bolts, and Nuts, and Set Screws (assorted).
Dobby Lattices, and Pegs.

FOR JACQUARDS.

Blank Cards: 400's and 600's.
Spare Hooks, and Needles.
Brass Springs.
Flax Thread, for Repairs of Harnesses.
Brass Mails.
Lingoes, Slips, and Spare Cumber-Boards.

HAND AND FOOT POWER LOOMS.

These looms are specially adapted to the requirements of native weavers in India, China, and Japan. They are now constructed from greatly improved models, some of which closely resemble in outward appearance the ordinary belt-driven loom. They are also capable of being worked at much higher speeds than formerly.

Type No. 1.—The action of transmitting power to this loom is practically the same as in the case of a bicycle. The weaver sits at a suitable height, and works the pedals with the feet. One attendant suffices for each loom, and a skilful weaver, using yarn of good quality, can turn off from 40 to 50 yards of narrow plain cotton cloth in a day of 12 working hours.

Type 2.—Is a loom specially designed for India; it can be operated by the native without his abandoning the customary use of a swinging sley and working the shed with his feet. The motion is imparted to the shuttle by means of two picking arms provided with straps, the opposite ends of which are connected to an equalising bar. This latter rocks on a central pivot, fixed in a rail at the front of the loom. The ends of the picking arms are cam-shaped in respect to the centres, which are carried by the brackets on the sley upon which the picking arms are fulcrumed. By this arrangement a long leverage is available at the commencement of each stroke, thus making it possible to get the shuttle under way easily. Thus the weaver is enabled to work the loom at a speed of fully 120 picks per minute, with no more exertion than is required by the old method.

FANCY LOOMS

According to the nature of the fabric to be produced, looms for weaving fancy goods require to be provided with mechanism for the insertion, in the weft, of different counts, colours, or materials; or with shedding arrangements that enable figured designs to be woven.

Looms for weaving cloths that contain a variety of wefts, require to be fitted with motions for bringing the different shuttles under the action of the picking motion, in their proper sequence. There are two distinct types of **shuttle-box motions**, namely: (1) Drop Boxes and (2) Circular Boxes. In the former type the shuttles are carried in a series of shelves, which can be raised or lowered to bring the required shuttle to the level of the

race-board. In the latter type the shuttles are carried in chambers formed round the circumference of a barrel, which revolves in either direction to bring the selected shuttle into the picking position.

Slow-running looms with fast reeds for weaving heavy goods are invariably fitted with **Drop-boxes,** of which there are many arrangements. The favourite motions in the Lancashire cotton industry are Diggles's box motion, Wright Shaw's motion, and a number of motions in which the movement of the boxes is effected by the aid of eccentrics.

Diggles's Motion is the oldest and simplest arrangement for controlling shuttle-boxes. It consists of a series of links of different heights, which are formed into a chain and worked round, beneath a lever, one link for every two (or multiple of two) picks. The lever is fulcrumed at its rear end, and connected by a rod from its forward end with a lower lever which carries the box rod, the latter being adjustable as regards its length or the height of the boxes. According to the height of the links coming under the bowl of the upper lever, the box rod is elevated, or allowed to fall, a distance equal to one or two boxes. A lift of two—or (as it is termed) "a skip of one box"—is the usual limit of a single movement, on account of the leverage which would be exerted upon a longer link, and the fact that the boxes must fall by their own weight, and the greater the drop the greater is the risk of rebounding. The length and weight of the chain render the motion unsuitable for long colour or wefting patterns, while adjustment of the chain consequent upon the breakage of the weft often results in the soiling of the weaver's hands and of the cloth. The motion finds its chief use to-day in wide slow-running looms, weaving cloths with simple wefting patterns or such as can be produced by comparatively short chains. In these cases its strength, simplicity, and certainty of action are decided advantages.

In Wright Shaw's Motion, which is a favourite in some coloured goods districts, the motion of the boxes is effected by the aid of cams, and controlled by a series of steel cards, which work over a square cylinder and act upon three fingers. Two of these fingers are at opposite ends of a swivelling piece that is secured to the top of a vertical shaft, while the third vibrates an arm which is secured to a tube that encircles the upper portion of the vertical shaft. A connection is made between the box rod and a pinion, which is spanned by a double

rack suspended from the end of a lever. The latter is fulcrumed at its opposite end, and has an anti-friction bowl at its centre, which can be elevated by one or other of two sliding cams carried by the low shaft of the loom. One of these cams is normally beneath the bowl, and has a throw equal to the lift of one box. And the other cam is brought beneath the bowl when a lift of two boxes is required, the change being effected by the rotation of the tube mentioned above, and a fork which enters the ring groove of the cam boss. The double rack is linked to an arm at the bottom of the vertical shaft, and (according to the direction in which the latter is swivelled by the action of the cards and cylinder upon its fingers) one or other of the racks is geared with the enclosed pinion, which is thereupon rotated in the corresponding direction when the cams lift the rack and lever, and a similar motion is transmitted to the box rod. That is, when one of the racks engages with the pinion the boxes are lowered, and they are lifted when the opposite rack is brought into gear. Thus the motion of the boxes is positively controlled—a feature that enables higher speeds to be attained; damage by obstruction is avoided, and arrangements are provided for stopping the rotation of the card cylinder when the weft breaks.

"ECCLES" DROP-BOX MOTION.

The principle of **Eccentric Box Motions** consists in effecting the movement of the boxes by a series of eccentrics, which can act upon the box-rod lever either separately or in combination. Thus with a pair of eccentrics a lift of one box can be obtained by the separate action of the small eccentric, or a lift of two boxes by the separate action of the larger eccentric, but the united action of both eccentrics may give a lift of three boxes. Most loom makers have their own arrangement of eccentric motions, which differ mainly in the method of actuating the eccentrics. In the "Eccles" Motion, however, a double crank and a pair of discs are employed in place of ordinary eccentrics, but the principle is the same.

These discs, although mounted separately, are so connected together as to form a combination of cranks, having different sweeps or throws, working about one common centre. The variation in the length of the throws is caused by one or more of the discs remaining stationary while the other revolves, or *vice versâ*; or by all the discs revolving together. By thus revolving at

different intervals, different distinct movements are imparted to the shuttle-boxes.

In order that the motion shall work intermittently, and thus allow time for the picking to take place, the discs are locked in position, and the motion is then held at rest. This is accomplished by the rim of each disc being provided with two notches, one opposite the other, into which the projections of bell-crank levers enter after each revolution of the discs. The discs are made to revolve by the vertical movement of toothed racks, which are thrown into and out of gear with pinions attached to the discs. The racks receive their motion from the tappet shaft of the loom, by the action of a crank mounted thereon, and through a bell-crank lever whose opposite extremity is centred upon a stud attached to a fixed bracket. Each disc is provided with its own rack, and each rack is coupled to and operated independently by fingers, which are capable of moving horizontally towards or away from the discs. The other ends of the fingers present themselves opposite the links of an ordinary pattern-chain, in which are arranged holes and blanks, according to the changes that have to take place in the weaving. The barrel round which the pattern-chain passes is mounted upon a vertical lever, which is caused to oscillate by the opposite end bearing against a cam on the tappet shaft.

Whenever a blank in the pattern-link appears opposite one of the fingers, during the inward movement of the chain barrel, the rack to which the finger is connected is pushed into gear with the opposite pinion, and the vertical movement of the rack gives the pinion half a turn, and the disc to which it is connected makes the necessary half revolution. In doing so the relative positions of the discs are altered, as are also the pins that connect them together.

The effect of this change is transmitted to a main crank pin, which, being connected with the discs, is moved towards or from the axles thereof in a vertical direction. A movement corresponding to that given to the main crank pin is at the same time imparted to the shuttle-boxes through a connecting rod, a rocking lever, and the usual upright frame that carries the boxes.

The chief objection to eccentric box motions is that a similar card in different parts of the chain may give quite different results: that is, it may either raise or depress the boxes, according to the previous position of the latter. This is due to the fact that the discs or

eccentrics are rotated in one direction only, which often causes broken patterns to be made through the weaver's inability to adjust the cards correctly after the breakage of the weft. This difficulty is overcome in a **Swiss motion,** in which the box-rod lever can be raised by any one of a series of hooks. These are lifted varying distances by a lifting knife, the selection being effected by cards and a cylinder. Each box has its own card, and any box of the series can be brought to the race level either by the motion or independently by hand when required. The boxes, however, fall by their own weight, and high speeds are not practicable.

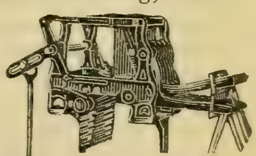
Circular Boxes are not so common as drop boxes in the cotton industry—probably owing to the fact that they can be used only in conjunction with loose reeds, and for light or medium-weight fabrics. The ease with which they can be operated, however, enables the loom to be run at the maximum speed—a decided advantage when fabrics of the class mentioned are woven. The barrel or cylinder is usually constructed to receive six shuttles, but as many as twelve may be used. The shuttles can be turned in either direction by a pair of hooks, namely, one on each side of the cylinder, which engage with studs (equal in number to that of the shuttles) at the outer end of the cylinder. The hooks are jointed to levers, which are fulcrumed near the centre and have similar hooks at the opposite ends. These latter hooks pass through slots in an upper lever, which is raised at each alternate pick by a tappet underneath its centre on the low shaft of the loom. A pair of bell-crank levers are fulcrumed at the bends in such a position that the lower ends of the vertical arms touch the heads of the hooks last mentioned, while the horizontal arms (which have pins on their under sides) rest upon a card cylinder, which is raised for alternate picks by a tappet. A hole in the card allows the corresponding lever to retain its position when the cylinder is pushed upwards, whereupon the head of the corresponding hook is thrust upon the full part of the slotted lever and is lifted when the tappet operates, thereby causing the boxes to be turned by the depression of the hook. A blank in the card, however, lifts the horizontal arm and draws the vertical arm of the bent lever away from the hook head, thus leaving the latter in the slot and unaffected by the lifting lever. It will be understood that only one hook can be brought into action at once, since

they act to turn the boxes in contrary directions. In the event of both hooks engaging with the cylinder pegs simultaneously, the lifting or slotted-lever yields either at its fulcrum or at a hinge joint between the fulcrum and the tappet. Parts are also provided for preventing over-running of the boxes.

As above described, the boxes can only be moved one at a time, which places some limitation upon the wefting pattern as regards the order of the colours. A "SKIP-BOX" MOTION, however, has been devised, whereby a movement of two boxes in either direction can be obtained, thus making it possible to bring any box of the series to the shuttle race. This greatly increases the colouring capacity of the loom.

DOBBY MACHINES.

With a few exceptions, such as the heavy goods previously mentioned, tappets are not generally used in cotton weaving when the pattern to be produced requires more than six or eight shafts of healds and as many picks to the round. Above that number, dobby machines are employed. These are now constructed upon principles which secure steady and reliable working, and permit of higher speeds than were possible with the older tappets, which combined fairly large heald capacity with facility for effecting changes of pattern. In the cotton industry dobby machines are used up to sixteen or twenty shafts of healds, and there is practically no limit to their capacity as regards number of picks to the round.



There is an infinite variety of dobby machines in use, both for general and for special purposes. They range themselves, however, into types, which may be described as "single-lift," "double-lift," "negative," "positive," "open shed," "closed shed," and "cross-border." The pattern may be determined by pegged lags, the paper or metal card, endless paper sheets, or metal projections on a barrel.

Single-lift Machines are those in which there is a single lifting agent (generally known as a "griffe") for the whole of the shafts. It is therefore essential that the whole of the latter should be returned to their original position, along with the griffe, after each pick, to enable a fresh selection to be made and lifted for the following pick. Such a method of working also gives a "closed shed,"

so termed because the shed is completely closed: that is to say, all the warp threads are brought to a common level after every pick of weft. On account of there being only a single lifter, the machine, and therefore the loom, cannot be run at a speed of more than 130 or 140 picks per minute, hence this type is only used on slow looms such as those for wide or heavy cloths. This machine can also usually be arranged to give a "positive" control over the movements of the healds by connecting top and bottom shafts to separate hooks which work opposite to one another: that is to say, when one is pushed over the griffe to be lifted, the other is pushed away therefrom. In the majority of cases, however, dobby machines are "negative" in their action: that is, they only operate to move healds in one direction, and require supplementary parts (such as springs, weights, or other motions) to bring the healds back after their action upon them.

In **Double-lift Dobbies** the selecting and lifting parts of the machine are duplicated, so that it is possible to begin to form a new shed immediately the preceding one begins to close; also the parts move at only half the speed of the loom. The result is a considerable saving of time and of power, which makes it possible to increase greatly the speed of the loom. Double-lift machines are either open shed or semi-open shed, the latter type also being sometimes called "centre" shed.

In Open-Shedding, a heald shaft once lifted remains up until its warp threads are required by the pattern to fall again. The standard machine of this type, which has practically displaced all others constructed on the same principle, is the **Keighley Dobby,** in which the hooks and draw knives or griffes slide horizontally and act upon a ⊣-shaped lever, whose centre remains stationary in the advanced position, notwithstanding that its ends, to which the hooks are attached, may change positions on successive picks. In a recent improvement, made by the original inventors of the machine, the hooks and knives are made to move in a sloping direction, with the object of preventing the miss-lifts that sometimes occur with the older machine. These are attributable to the hooks being shot off the knives, owing to the end of the upper hook lever passing below the level of the knife when at the extremity of its stroke, and of the lower lever passing above the level of its knife.

In the Semi-open or Centre-shed Dobby, a hook and its attached heald shaft falls with its griffe until the

rising hook and griffe come level with them, whereupon the shaft—supposing it to be so required by the pattern—is taken up again by the ascending hook and griffe. The standard machine of this type is that known as the **Blackburn Dobby**, in which pegged lags come into direct contact with vertical hooks (of which there are two sets, each set acting upon the same set of heald jacks) to determine their position with respect to the griffes, which rise for alternate picks. There are also two chains of lags, namely, one for odd and the other for even picks—an arrangement that sometimes causes trouble by the lags getting out of their proper sequence. In an improved dobby (White's) of this type, there is only one set of lags, which is a decided advantage. This semi-open shed dobby is largely used for leno and dhootie bordered fabrics, on account of the facility for "shaking" or bringing crossing and crossed warp threads level in the former case, and for its capacity as regards hooks—which may reach up to 40—in the latter.

Cross-border Dobbies are used when a change of weave has to be made in towel headings, or for bordered handkerchiefs or serviettes. In a single-lift machine this is easily provided for by adding one or two extra rows—according to the number of weaves required—to the card cylinder, and bringing the rows opposite to the hooks as the pattern punched upon them is required. In the double-lift machines of the horizontal type, an additional barrel and set of lags is provided, which are extended over the second barrel. In some cases the change of barrels has to be effected by the weaver, but it may be effected automatically by supplementary lags and a chain connection to the ends of the barrel lever.

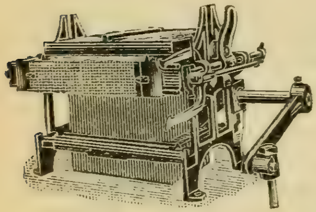
Of dobby machines for special purposes, the **damask dobby** may be mentioned. This is used for damask table covers and serviettes in which the pattern consists of simple rectangular figures, and both figure and ground are bound by a uniform weave, *e.g.*, a twill or a satin. The shafts and hooks are grouped in sets according to the weave (that is, fives for a 5-end satin, and so on), and the latter is controlled by a supplementary cylinder, while the pattern is determined by high and low links in a chain in one case, and by a continuous sheet of paper in another.

When pegging dobby lags, careful regard must be paid—(1) to the value of the pegs—that is, to see whether a peg causes a hook to be lifted by leaving it over the griffe, or whether it pushes the hook off the griffe and thereby causes it to be left down; and (2) to the direc-

tion in which the lag barrel revolves and the order in which it presents the lags or rows of pegs to the hook feelers.

JACQUARD MACHINES.

A jacquard machine and a thread harness are generally used in cotton weaving for patterns in which the warp threads require to work in more than 20 or 24 different ways. The principle of the jacquard is very simple: namely, that hooks formed at the upper ends of vertical wires can be allowed to remain over, or be pushed away from, a lifting griffe, which is raised and lowered for every pick of weft by the presence or absence of holes in a paper card that is pressed against the needles by a perforated cylinder. Each needle controls a hook, and both are arranged in rows, which vary according to the capacity of the machine. A tail cord or neck-band is fastened to the bottom of each hook, and each cord has suspended from it a number of harness twines, which pass through the holes of a cumber-board that keeps them straight and opened out to the required width. Below the cumber-board "mail" eyes are tied upon the twines to receive the warp threads, and these lingoes or wires are tied to bring hooks, twines, and warp threads to their original position after they have been lifted by the griffes. The cylinder is pressed against the needles—which project through a needle board and have springs at their rear ends to press them forward again after the action of the cylinder—once for every pick; and as it moves away from them the cylinder is turned a quarter of a revolution to present a fresh card facing the needles. This describes the "Single-lift" Machine, which receives its motion from a sweep or crank at the end of the loom crank shaft connected to the griffe lifting lever.



"Double-lift" Machines are designed to give higher speeds, and there are two kinds: namely, double-lift single-cylinder and double-lift double-cylinder. In the former case each needle controls a pair of hooks, which are tied to the same bunch of harness twines and are capable of being lifted by a pair of griffes that lift for alternate picks of weft. In the latter case hooks, needles, griffes, and cylinders are duplicated, so that all parts

move at half the loom speed. Hence the latter can be considerably increased compared with that of a single-cylinder machine. On the other hand, the double-cylinder machine requires the cards to be laced in two sets, one for odd-numbered picks and the other for even-numbered picks—an arrangement which sometimes causes spoiled cloth to be produced by the cards getting out of their proper sequence.

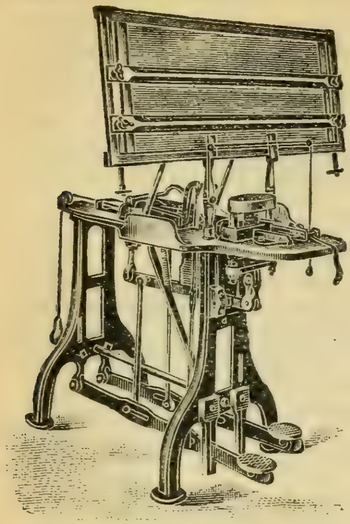
Cross-border jacquards are also used for bordered fabrics, such as quilts, table covers, serviettes, etc., when the centre consists of a simple repeating pattern. Middle and border cards are then put upon separate cylinders, which operate the same set of needles, and the cylinders are alternately put into action as required by hand in some cases and automatically in others.

The standard **Sizes of Jacquards** used in the cotton trade are as follows:—

100's	which contains	26	rows of hooks	4	to a row or	104	hooks in [all
200's	,, ,,	26	,, ,,	8	,, ,,	208	,,
400's	,, ,,	51	,, ,,	8	,, ,,	408	,,
600's	,, ,,	51	,, ,,	12	,, ,,	612	,,

For patterns of larger repeats than can be got from a single machine, two or more are mounted together: thus two 400's or two 600's are fairly common in the cotton trade.

The tie-up of the harness refers to the distribution of the harness-cords in the cumber-board and the style of the pattern produced. Common ties are:—(1) The "lift-over" tie, in which the twines are tied in succession to the hooks from the first to the last, after which the next twine is tied to the first hook and the same order repeated. This gives a number of repeats of the same pattern across the width of the cloth. (2) In the "centre" or "vandyke" tie-up the twines are tied in regular succession from first to last hooks, after which the next twine is tied to the last hook but one, and this order repeated backwards until the first hook is reached again. The result is a pattern twice the size of that obtained by the "lift-over" tie on the same number of hooks, but of symmetrical character. (3) In a bordered" tie-up a portion of the hooks are set apart for the border of the cloth and the remainder for the middle, and either or both of them may be lift-over or centred. (4) "Single" or "solid" tie has only one twine and one warp thread to a hook—an arrangement which is necessary for weaving names or devices in the centre or borders of fabrics.



CARD-CUTTING MACHINES.

Function. — To punch the holes in jacquard cards, according to specified designs, and in the order they are to operate the needles.

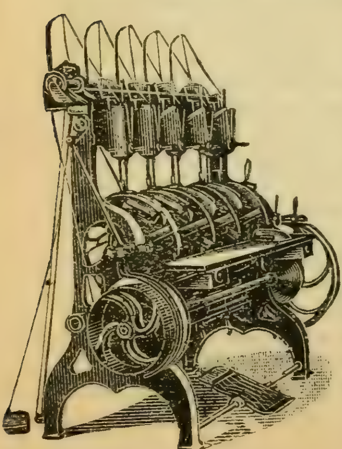
Plate Machine.—The operation on this machine is slow, the plate being usually reset for every distinct pick in the design; but if there are many similar picks in the design it is obviously the quicker, as one setting of the plate will enable all similar picks to be cut in a few moments.

Piano Machine.—This machine feeds the card into the line of 8, 10, or 12 cutting punches controlled by the fingers, so that the fingers indicate the correct punches; one foot cuts and the other foot (or treadle) controls the movement forward of the card. A good cutter will cut from 100 up to 120 cards per hour (300's cards).

JACQUARD CARD LACING MACHINE.

Function.—Joins together the cards for controlling the shedding in weaving fancy cloth.

Description.—Are made with three, four, five, or six heads, each provided with its own needle and shuttle. Each head is adjustable independently, either to the right or left hand; and the machines are generally made in two sizes—one for cards from 4 to 26 inches, and one for cards up to 42 inches long. The length of stitch can also be adjusted, up to 2½ inches.



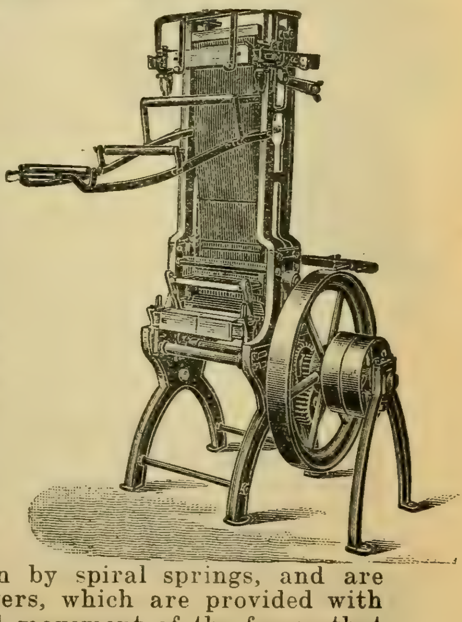
The cards are placed by the operator upon feeding-wheels, having carrying-pins, which retain and accurately space the cards while the forward motion of the wheels feeds them between the needles. The stitch made in this operation should be on the lock-stitch principle, so that each tie is independently secured.

Production.—From 15 to 18 cards per minute when operated by foot power, and 28 cards per minute when mechanically driven at 80 revolutions per minute.

JACQUARD CARD REPEATER.

Function.—To repeat or duplicate pattern cards for weaving from an original set.

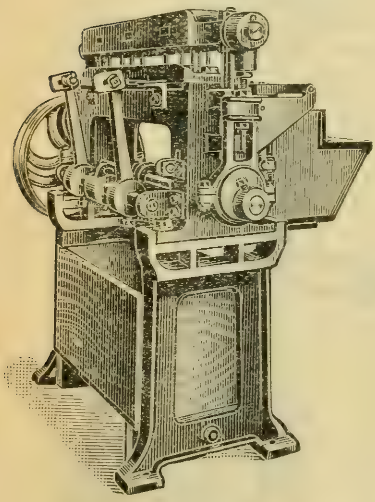
Description.—Is an adaptation of the jacquard principle to card-cutting. Consists of a stationary punch plate, above which is a sliding frame carrying punches firmly secured thereon, and locked up or down (as needed) by the aid of a comb. This sliding frame is lowered by means of eccentrics upon one of the shafts when the punches are required to cut the card, and when the operation has been performed is raised again to its former position, where it waits ready for the next card to be brought upon the plate. The cards pass over the cylinders of the punching machine on their passage through, being operated in a manner similar to that of the jacquard attachment itself, and the cards after being punched are thus changed readily.



The jacquard machine is mounted immedately-above the punches, to one of which each hook is connected by what may be termed a compound protecting wire. This is formed of a pair of wires having an eyelet at one end; the end of each wire is put through the eyelet of the other, and a spiral spring placed upon them between the two eyelets keeps these apart, and thus forms between the jacquard hook and the punch a spring connection, which does not become slack. The locking-comb is constructed in the usual manner, but the rods upon which it slides are he'd in position by spiral springs, and are actuated by oscillating levers, which are provided with slots to permit the vertical movement of the frame that carries the punches. These levers are bell-cranked, and

are operated from the cams on the shaft before mentioned.

In working, the jacquard hooks are lifted by the "griffe" and raise their corresponding punches, which are then (along with the other punches left down) locked in their respective positions by the comb. The revolution of the shaft carrying the eccentrics then draws down the punches to the card which is already upon the fixed punch-plate. The raised punches make no impression upon the card, but the others punch holes into them; and as there are as many rows of punches as there are rows of holes to be punched in the card which is being repeated, a whole card is punched at one revolution of the shaft. The operation being finished, the eccentrics raise the punches from the card, which automatically moves forward, bringing a fresh card upon the plate, whereupon the operation proceeds as before.



The first set of cards are cut in the ordinary way from the design by the piano-machine. They are then laced together, and used in the jacquard to actuate the repeater, which then automatically reproduces a set of cards exactly according to the pattern.

Peg and Lace Hole Machine.

Used in conjunction with the foregoing machine to cut the holes in the blank cards correctly, so that they shall correspond accurately with the punches of the repeater.

Both machines are made in sizes to cut up to 600's cards.

Cylinder Peg Attachment.—For prolonging the life of pattern cards used in jacquard machines. Consists of a small bracket, provided with two bosses or projections. These latter are bored out to admit two pegs, either of which may project outwards from the bracket, and operate with the pattern-card. Space is provided in the projections for light helical springs, which surround the shanks of the pegs, and by butting against the shoulders thereof press them outwards when required to do so.

But as one peg only is in use at a time, a small pin is inserted in either the one or the other. When the centre peg-holes of a set of cards have become worn by constant usage, the cards can be used again for a similar period by simply putting the centre peg out of action, and working with the one at the side. The change is made by releasing the side peg and depressing the centre one, and securing the latter with the pin withdrawn from the former.—*Patented.*

THE SETTING OR TIMING OF POWER-LOOMS, DOBBIES, AND JACQUARDS

LOOMS.

The relative time of action of the various moving parts of looms cannot be stated dogmatically, for the reason that no two loom-makers build looms identical in proportion, and that the setting must necessarily vary with the kind of fabric made and the speed at which the loom is run. Nevertheless, upon the correct setting of the various parts of the shedding motion or motions depends not only the quality of the cloth, but also the production. The time of action of this motion is governed by the kind of fabric to be made, quality of the material to be used, and speed of the loom; and in its turn it regulates the setting of most of the other motions. So much effect has the time of action, etc., of this motion upon the fabric made, that by a slight alteration in the setting, a fabric can be so changed that the portions of the cloth made—if seen apart before and after the alteration—might well be taken for quite different fabrics. Thus a stiff bulky cloth may be changed to one that is slack and thin; a narrow one increased in width; one that is quite uneven made perfectly regular in appearance, etc.

The loom itself has very much to do with the position of the harness and the time of the shedding. Looms vary greatly in their proportions, and there are no recognised standard measurements for height and depth in relation to reed space. If the proportions were alike in all looms, it would be possible (at least theoretically) to give settings for looms on similar qualities that would yield similar results: but makers do not agree upon their proportions, and it is therefore impossible to give any hard-and-fast rules for setting looms. Thus

the loom cranks may give movements varying from 4½ to 6 inches, and the depth of the loom or the stretch of the warp may vary by as much as from 10 to 12 inches, in looms making the same class of work. Similarly with the construction of tappets and other shedding mechanism: the dwell of tappets varies sometimes as much as 200 per cent. Again, the shedding motion itself may be of a distinct type: a tappet with a quick change and long dwell cannot be set to the same time as a tappet with a slow change and a short dwell—and one cannot, for example, expect to get the same results from an eccentric shedding motion (as largely used in France and to some extent in this country) as from the ordinary tappet. Therefore one setting will not do for all looms; indeed the shedding mechanism of two looms may vary in times by quite 90 per cent. of crank movement.

In the following notes—unless where otherwise stated—the various parts will all be timed relative to the circle of movement of the cranks in degrees, the top centre being taken as 0 deg., the front centre as 90 deg., the bottom centre as 180 deg., and the back centre as 270 deg. The relative positions of the crank shaft and the connector pin, and the relative proportions of crank, connecting arm, and lay swords, all affect these positions; but for practical purposes they may be taken as given above. Very often these respective positions are known as 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock; but, although that nomination serves its purpose for easy reference, it is preferable to use degrees of movement.

The time at which the shed is fully developed or is first fully opened varies from about 120 deg. (*i.e.*, 30 after the front centre) to 220 deg. (*i.e.*, 40 after the bottom centre). These are extreme cases found in practice; but probably the usual position is about 160 deg. to 180 deg., or just before the bottom centre. In extreme cases the shed remains fully open until the top centre is passed; but usually it begins to close at about 245 deg. (or 25 deg. before the back centre).

Apart from effect required in cloth, shedding requires to be early developed in wide looms, and also in fast-running looms. Where "**reediness**" must be avoided and the warp is entered two or more ends per dent, it is essential that the shedding should be set very early, so as to obtain good "cover." Equal spacing of the warp ends—or good "cover"—results from the weft being

beaten into place after the warp ends have formed a cross behind; and to obtain the best results, the heald eyes of the front and back shafts ought to be level when the reed is at least half-an-inch from the fell of the cloth. The position varies with the structure of the cloth and the make of the loom, but it is always requisite that the healds should be level when the crank has just crossed its top-centre position. A similar position is also necessary when a stiff and firm fabric is required, considerable drag or tension being also put upon the weft.

To aid "**cover**" it is customary, in weaving plain cloth, to raise the back rest and drop the harness as far as possible. To get as much "sink" as possible with the least alteration in the loom parts it is best also to raise the breast beam of the loom; or if at its full height, or difficult to change, to tie a smooth wooden stave across its top surface. It may be well to point out here that it is the difference between the angles formed by the warp lines at the top and bottom of the open shed that influences the "cover"; consequently the height that it is necessary to raise the back rest depends upon the length of the "stretch" or "porrie" of the warp: the longer the stretch the higher the back rest must be lifted. A 2×2 lease is picked, and the unequal shedding, causing changing tension on odd and even warp ends, forces the ends to stay apart—seeking the position of least resistance, the middle of the weft floats—and so produces a very well-spread cloth. Care must be taken to avoid too unequal straining, or the warp breakages may cause more damage and loss of production than will be compensated by the better cover.

To obtain the best "cover" results, *i.e.*, to have the warp ends standing apart and straight, it is necessary to have the warp well tensioned; and in the case of fine and tender warps it will usually be found best to raise the warp beam into the position of the back rest, and tension the warp with "balance weights." For those who are unaccustomed to the use of balance weights, it may be explained that instead of securing the inside end of the weighting rope or chain to the loom framing, a small weight is attached to the end of the rope, of just sufficient weight to prevent the weights suspended at the other end of the rope from slipping to the ground. Such an arrangement considerably helps the warp to stand the stress of the shedding and beating-up, and by its

regular easing motion aids the construction of a well-made cloth. Some managers prefer to use "easers" of various descriptions in place of balance weights; but for most qualities it is generally found that these balance weights when properly used are easier on the warps, and give the best cloth effect. If there is too much **"sink"** or **inequality of tension,** the cloth appearance may be quite spoilt by the fabric becoming corded. Occasionally, when it is not possible or not advisable to pick a 2×2 lease—especially in light narrow goods—a well-spread cloth can be produced by tying two light lease-rods in front of the ordinary lease-rods, one being placed above and the other below the warp. This causes equality of tension in the warp, and produces a very well-spread cloth. In twill cloths the effect produced by increasing the "sink" of the warp for producing better "cover" should be carefully watched, as the effect on the prominence of the twill is considerable.

In light and open fabrics unevenness may often be noticed, and when examined closely it is generally found that the picks of weft are grouped in twos or fours, with **"cracks"** between each group. To overcome this defect, the best method is to set the shed to close late, the shed being levelled when the reed is against the fell of the cloth. Where the loom is working "tabby" with two pairs of plain tappets, the best result is obtained by making one pair close a little before beating-up, and the other pair a little after. In fancies, working with plain tappets and a dobby, a similar effect can be produced by setting the dobby to act a little before the tappets. Where the tappets are adjustable separately, they are occasionally set so that in rotation they "lead" a little, *i.e.*, the first shaft is set to move a few degrees before the second shaft, and so on.

Large cracks are distinct from those mentioned above. When a large crack extends, at fairly regular intervals, from selvedge to selvedge or up the middle of the cloth, it will be generally found that one of the shafts has been adjusted a little higher or a little lower than the others, or that its movement is greater than the other shafts. This produces inequality of shedding whenever the faulty shaft is moved, and the result in the fabric is a crack. An even more common fault is the formation of cracks up one edge of the fabric. This is due to a similar error, the cause in this case usually being that at that side where the crack is formed one of the shafts

has been tied a little higher or a little lower than the others, while the opposite end is correctly adjusted.

Late shedding is generally the most satisfactory for **light fancies** and for **tender warps.** With heavy cloth and a fine reed it is sometimes necessary to set the shedding late, in order to reduce straining. Generally the lease-rods should be so adjusted that the distance from the fell to the middle of the harness equals the distance from the middle of the harness to the front lease-rod. By bringing the lease-rods closer to the harness the acuteness of the shed angle is increased, as is also the "cover" in the cloth; but the strain on the warp is likewise made greater, and results in a greatly increased number of warp breakages.

The **selvedges** of the fabric are greatly influenced by the time of the shed; and, other things being equal, a late shed gives the best results. Selvedges must be watched very carefully, as a badly formed shed will produce a very unsightly selvedge. Bad selvedges are commonly caused by one stave being pulled lower than the other, or otherwise not evenly adjusted—and the unevenness results in a very poor edge.

DOBBIES.

The timing of a dobby is practically the same as for a tappet, and methods such as are advised for tappets should be adopted for the production of satisfactory fabrics.

Before starting a new warp, see that the dobby is lubricated and in working order, and the necessary parts are in place for the weaving of the required number of shafts. This care prevents mistakes in the cloth, sometimes erroneously attributed to the pegging of the lags. The bottom springs should be tested and any shewing weakness rejected. Carelessness in this respect generally means endless trouble at the loom: one or other of the shafts not bottoming properly causes breakage of threads, "trapping" of the shuttle, etc., and produces in the cloth generally an uneven appearance.

Where the number of ends drawn in the various shafts differ, make allowances in choosing the springs; but the springs used upon the same shaft should always balance. Sometimes a proportionately large number of ends may be shewn in the pattern as being drawn upon one shaft. Wherever possible this should be avoided by the designer, and the pattern be made as balanced as

possible both as regards sequence of lifting and number of ends entered in the various shafts. If it should be necessary to weave a pattern where a large number of ends are drawn in one shaft, it is sometimes advisable to divide up the ends upon two shafts and operate from two jacks. This makes better weaving, and it eases the dobby where the quality is at all heavy. In weaving some fabrics this is not always sufficient, and the best method is to attach one shaft to two jacks.

Light fancy fabrics, where the design is not well balanced, often shew thick and thin places ("**pattern-marking**," as it is called) where the changes take place, and in some cloths "**cracks**" result. The regarks previously made on tappet weaving are applicable in this case, but other means also are not seldom required to overcome the fault. One method suitable for light fabrics is to pass a leather strap, cord, or chain, round the warp beam, and (working it from one or more of the jacks) slacken it when there is a thick place and tighten when there is a thin place or crack. Generally it is best to make the movement one or two picks before or after the mark, according to whether it is thin or thick. This method is very similar to the usual one of operating an extra weight, the place of the weight in this case being taken by one or more springs attached to the leather and fixed to a convenient part of the loom. Another method is to operate through the take-up motion, an appliance of one kind or another (there are several) being attached to vary the take-up, more being taken up where there is a thick place formed, and less where there is a thin place.

With experience and by a little experimenting a fabric otherwise promising to be unsightly can be made to look quite even by the above methods of rectification. Fabrics woven in jacquard looms which shew similar faults can be "levelled" by the same methods, but a number of hooks should be used to operate the respective mechanisms, and it is always advisable to introduce a lever or levers to reduce the strain on the jacquard hooks.

When setting a dobby, the position of the pulling knives should be carefully adjusted. Top and bottom knives alike should move from ¼ to ½ inch clear of the hooks, and the blades should be an equal distance from the hooks at each end. This is important, for sometimes

a knife is farther in at one end than at the other, and catches the hooks. See that none of the parts are shewing "play," but that all are moving evenly and the correct distance. Where cords are used to convey the motion from the jacks to the shafts, the pulleys should be separated and greased well to prevent sticking, and before finally screwing-up they should be tested for freedom of movement.

JACQUARDS.

Jacquards differ greatly alike in construction and method of use, and one of the most important features in successful jacquard weaving is steadiness of working and freedom from shock or vibration. Card cylinders should not be too closely set, nor the griffe lifting levers badly balanced, and the bearing of bottom shafts of looms should not be slack or worn, etc. Vibration is harmful in a jacquard, as it increases wear and tear in the mechanism, and tends to make an unsatisfactory cloth. Common results of shock in a jacquard are an increase in the number of harness cords that break, of weights separating from the cords, and in many cases a tendency towards stitching in the cloth.

To remedy vibration, have the jacquards mounted upon a steady base. Usually in mixed sheds where jacquards are not mounted over a majority of the looms, the jacquards are carried on rails supported by pillars from the cross-rails of the looms with occasional stays from roof cross-beams. Such an arrangement cannot possibly be steady, and it is unadvisable in a shed where many jacquards are in operation. The best method is to have the jacquards carried upon steel girders of H or inverted channel section, and these girders supported upon pillars from the floor, or on special brackets fixed above collars cast upon the pillars carrying the roof. Cast-iron stools of suitable design should then be fixed across the girders to support the jacquard, the stool being arranged to allow of horizontal and vertical adjusment of the jacquard. Such stools are usually constructed with a slightly raised bead round the edges, so that they act also as trays to catch the drip of oil from the jacquard.

The method of driving jacquards is sometimes a prolific source of vibration, and should be on the latest principle minus the long levers and connecting rods usually employed.

Timing Jacquards.

The time of shedding of jacquards varies just as the time of a tappet or dobby does, and must be fixed according to requirements. In the majority of weaving sheds the double-lift jacquard has entirely displaced the older single-lift machine, the latter being now only used for special purposes, or in sheds that are very much "out of date." Jacquards are usually timed by the movement of the card cylinder or cylinders. In actual practice the middle of the dwell of the cylinder in contact with the needles may vary from about 215 deg. (or 35 deg. after bottom centre) to 290 deg. (or 20 deg. after back centre); but generally the position is near the back centre, 265 deg. being a common position. Usually the cylinder first engages the needles from about the bottom centre to 40 deg. after the bottom centre. The dwell of the cylinder in contact with the needles varies from 10 to 20 deg. with double-lift single-cylinder machines, to 50 to 60 deg. with double-lift double-cylinder machines. The double-cylinder jacquard works more smoothly than the single-cylinder, and produces more satisfactory work with less wear and tear in cards.

Spring card pegs should always be used, as they do not puncture the cards or otherwise tear them when the cards get coiled round the cylinder. The card cylinder of a single-lift jacquard is set 180 deg. in advance of what is the right position for a double-lift jacquard. Common positions for middle of dwell are 50 deg. to 90 deg., the earlier positions being the more common. The cylinder usually has about the same dwell as a double-lift double-cylinder jacquard. Single-lift jacquards working on heavy goods should always be balanced by means of springs or dead weights. The card cylinders should be driven independently, preferably by eccentric and levers, from the crank shaft in a double-cylinder jacquard.

Harnesses.

Harnesses should be carefully prepared and levelled; a harness badly tied up becomes a lasting cause of trouble to weaver and overlooker, and can never give satisfactory work, for the ends always either float above or below the cloth. Wherever possible it is advisable for productive reasons to prepare the harness away from the loom; but where the work is of a very heavy or particular nature, the best results are obtained by "mounting" or tying-up the harness in the loom. The

actual position of the mail eyes in levelling depends upon the relative positions of the breast-beam and lay, and also upon the man tying the harness. The usual way is to raise or lower the back rest until level with the breast-beam and then measure down half the depth of the required shed plus $\frac{1}{4}$ inch to $\frac{3}{8}$ inch. In mills where many jacquards are used this is usually done by means of standard brass gauges, cut to sizes suitable to the types of looms used. The "lingo" weights or "leads" depend for their size upon the quality of the fabric to be made, and in broad work it is often advisable to have heavier weights for the sides, owing to the increased friction; and in every case it is preferable that the selvedge weights be heavier.

Wide looms with a varied tie-up—where the jacquard is not quite over the middle of the loom, or where two or more jacquards are used—should be fitted with a grid or heck, made of stout wire placed about three inches below the bottom of the hooks of the jacquards. These grids ensure that the lift of the mail shall be identical from selvedge to selvedge. For a similar reason, and to avoid friction as much as possible, it is best to place the jacquards high up.

Comber-boards, &c.

The middle hook of the jacquard on looms with only one machine should be immediately over the middle of the comber-board, the position being found by means of a plumb line. Comber-boards should be secured by strong brackets, slotted to allow of vertical and horizontal adjustments. The comber-board should be fixed as low as possible, the position being just clear of the upper shell or reed-cap, should be level from selvedge to selvedge, from back to front, and should be parallel to the reed. Where the tie is a varied one, and where allowance has to be made for alterations in width, etc., the comber-board should be constructed of slips. Slips are more economical than solid boards, as the holes wear more rapidly at the ends of the board, and where slips are used these can be replaced where badly worn. Harness reeds, in place of comber-boards, are very suitable for many classes of fabrics, as they are more adaptable to changes of quality, pattern, etc. They are easier upon the harness, are cheaper in first cost, wear longer, and are more easily repaired than comber-boards.

Before starting new harness each row should be split down to break away any cords that may be holding to-

gether, and in the case of varnished harnesses the cords and comber-board should be dusted well with French chalk. It is advisable that the first warp worked in a new harness should, if possible, be one of low quality, so that any roughness may be rubbed off the cords without causing undue trouble to the weaver on account of warp breakages. Weavers should on no account be allowed to tie up broken cords, and the "tackler" ("tenter") should split down the harness in every case when tying-up a broken end, and should make sure that in carrying down the cord it does not get twisted round any of the other cords in the harness.

Adjustments, &c.

The card cylinder should be very carefully adjusted to the needles, any needles bent at the point being straightened, and the position of the cylinder altered until the needles come exactly in the middle of the holes. The position of the card pegs should also be checked, and the pegs be reset if the fully cut card does not correspond to the cylinder. When fully down, the hooks should be just over the blades, and the blades should be about $\frac{3}{8}$ inch below the hooks. Occasionally jacquards are made where the spacing of the blades does not correspond with the spacing of the rows of hooks—so that when the front row of hooks is set to the front blade, the back blade is either pressing against the back row, or else the second back row of hooks is being pressed forward by it. Such a machine requires re-setting by the makers. Sometimes the blades are set over the hooks—with the result that on descending some of the hooks are caught and doubled under the blades.

Jacquards carefully examined and set before starting are easily kept in working order, and the little extra time spent at the start is more than compensated by the time that would otherwise be required later in setting and re-setting cylinders and griffes, in tying-up broken cords, in straightening bent needles and hooks, in having cards repaired, etc. The turning catch should be set to just turn the cylinder, and the card guide rollers should not be too far apart—4 to 5 inches is quite enough—while the head of the card frame should be well below the level of the top of the cylinder.

To Distinguish Jacquard-woven from Dobby-woven Cloths.—The surest way to identify a jacquard-woven cloth is to examine it for faults. The faults made by a jacquard are not such as are generally made by a dobby,

and *vice versâ*. Thus "stitching" as produced by a jacquard is quite unlike dobby "stitching"; "scobs" and "floats" produced across a fabric by a faulty jacquard are never caused by a dobby; and as a "wrong lift" in a dobby shews equally all over the cloth it cannot be mistaken for a jacquard error, which more often occurs occasionally, the repeat of the jacquard pattern usually being many times the repeat of the actual pattern. There are many such faults that a weaving expert can detect, and it is only by such faults that anyone could definitely declare that any single fabric had been made by either a dobby or a jacquard.

LOOMS BANGING-OFF

Hints to Overlookers & Loom Tacklers or Jobbers

One of the most common faults in connection with fast-reed looms which an overlooker, or loom tackler, is called upon to remedy, is that of looms "banging-off." Such well-known and often-used terms as banging-off, knocking-off, and knocking-up, which designate perhaps the most prevalent fault where fast-reed looms are in use, indicate that the stop-rod tongue has engaged with the frog and stops the loom very suddenly, owing to the stop-rod blade not being raised sufficiently high to clear the frog on the forward movement of the sley. Generally speaking, a loom of the fast-reed type being subject to banging-off is in need of constant repair; but the extent to which repairs are necessary can be very largely governed by the tackler himself. The failure of the shuttle to enter the shuttle-box sufficiently; a rebounding shuttle; the shuttle not reaching the box at all; breakage, wearing, and incorrect setting of certain parts—all these are, briefly, the main headings under which the majority of the causes of banging-off may be placed.

Driving Belts

The use of a slack or jerky driving belt is followed by the loom being unsteadily driven, resulting in the pick being adversely affected, and sometimes failing to drive the shuttle properly from box to box: hence the stop-rod blade is insufficiently raised, and banging-off occurs. A belt which is so slack as to slip excessively will obviously be specially noticeable when picking should take place, owing to the shuttle not being subjected to the requisite picking force to drive it fully into the opposite box in time.

A good overlooker generally finds it possible, by carefully watching the loom when in operation, to detect

where the root of the trouble lies; or by slightly gripping the sley cap, or hand tree, as the loom is in motion, notably on narrow looms. A loom belt which is too thick, hard, dry, or unpliable, does not cling satisfactorily to the loom pulley, and thus part of the effective driving power is lost, causing a weak pick and giving the loom parts a jerky movement. In some cases of banging-off, the trouble has been remedied by having the hair side of the belt in contact with the pulleys instead of the grain side; the former is the common method in America, while the grain side is generally adopted in Great Britain.

In weaving sheds that are subject to sudden atmospheric changes in both temperature and humidity, sufficiently so as to cause the belts to become very dry, it has been found very efficacious to apply to the outside of the belt a dressing composed of neatsfoot oil and tallow. An application of this dressing once weekly for a few weeks, and then on alternate weeks, increases the life of the belt. and at the same time keeps the driving face sufficiently moist to ensure the desired grip on the pulleys. The loom pulley should also be examined: for, if it is a trifle loose, it may cause banging-off owing to insufficient picking power, the weakened pick preventing the shuttle reaching far enough into the opposite box in time.

Shed Adjustment

By failing to adjust the sheds to "bottom" properly, the progress of the shuttle is retarded, or "choked," as it passes through the shed, and the shuttle may be raised in contact with the spindle stud, or the shuttle may fly out of the shed altogether. If the weaver maintains too much weight on the weight levers, or the weights be placed too far away from the fulcrum of the levers, banging-off is often caused, owing to the progress of the shuttle being interfered with.

Picking

By picking too late, the speed of the shuttle would be somewhat checked, and the stop-rod blade may engage with the frog before the shuttle can properly enter the box, or the shuttle may be completely trapped in the closing shed. Picking too early results in the shuttle being picked into the shed before the latter is properly open, thereby depriving the shuttle of some of its power. The size of the shed should be large enough to clear the shuttle adequately and prevent it from being retarded on one hand, but not at the expense of having so large a shed, or overshedding, as to tension the yarn excessively on the other hand when the shed is fully open.

Picking Cam

If the picking cam point is badly worn, picking power will be partly lost, and thus cause a weak pick from that side of the loom. Should the picking shaft not revolve freely in its cup, or footstep, and collar, or swan neck, part of the power which ought to be imparted to the shuttle will be expended in moving the picking shaft, resulting in a weak pick. By allowing a picking stick to work when it is loose and slip back in its cockle, the picker is only allowed to travel part of its proper distance on the spindle, and thereby fails to transmit sufficient

picking power to the shuttle. Should either the picking cam, or the picking shell, become a trifle loose, or the picking stick be breaking, an occasional false and later pick, or an insufficient pick, will be caused.

Cleanliness

Dirty and sticky shuttle-boxes will retard the shuttle speed either when entering or leaving the boxes; but by thoroughly cleaning them, using paraffin oil to the boxes if necessary, this cause of banging-off may be removed. Dirty and sticky shuttles are caused chiefly by weavers troubled with sweaty hands. Rubbing of the shuttles all over with loom oil every Saturday and allowing the oil to penetrate into the wood over the week-end conduces to keeping the shuttles smooth and polished. In fact, banging-off has often been remedied by applying a little oil on the front and back of shuttle. (Care must be taken not to apply oil to shuttles to the extent of causing oil-stained weft yarn.

Strength of Pick

Too strong a pick delivers the shuttle across the loom in a "savage" manner and rebounds somewhat, thus preventing the shuttle from receiving sufficient power on the next pick and allowing banging-off to occur. An excessive amount of pick can also cause the shuttle to strike against the box front as it enters the box, thereby preventing the shuttle from pressing the swell far enough back. Rebounding can also occur when the check strap is too slack, while on the other hand the shuttle is prevented from passing into the box far enough if the check strap is too tight. The stop-rod blade may be set to have insufficient lift, and thus cause banging-off even when the shuttle is full up in the box. When the shuttle is in the box properly, the blade on the stop-rod must clear the frog by $\frac{1}{8}$ to $\frac{1}{4}$ in.

Inspection

Pickers should be inspected: for, if they are broken, the shuttle may be given a very erratic course, and crack in the box, owing to striking the box sides; a clicking noise is thus set up, which is easily distinguished. A broken picker may also fail to impart the requisite power to the shuttle. Both the shuttles used with a loom ought to be equal in size, otherwise one of them will not lift the stop-rod blade high enough, or may occasionally rebound. A pair of shuttles ought also to be equal in weight. If the finger on the stop-rod has slipped, the shuttle as it fully enters the box will not raise the stop-rod blade over the frog. A badly worn race plate, reed not at the proper bevel, a crooked spindle—all cause the shuttle to travel crooked and prevent it from reaching the opposite box properly.

Wear and Tear

Should the footstep of the picking shaft have worked loose, the picking power will be reduced. Inattention to oiling the picking bowl often results in a flat surface being worn on the bowl, and the contact of the nose bit and the flat part of the bowl generally causes a false pick, whereupon the loom knocks up. In case the spindle is not regularly and sufficiently oiled, the movement of the picker

will be obstructed and power be lost, in addition to subjecting the picker to excessive wear. Swell springs which are excessively tight prevent the shuttle from entering the box to its full extent, and the greater resistance of the swell may require more picking power from one or both sides of the loom to eject the shuttle from the boxes. A slack, weak, or broken swell-spring may permit the shuttle to rebound.

Worn swells and swell pins, and shuttles worn in width, all prevent the stop-rod blade from being raised high enough to prevent banging-off. Shuttles which are worn round or boat-shaped at the bottom will make a cracking noise when entering the shuttle box, especially at the off side, and cause banging-off. On placing a steel ruler along the bottom of any suspected shuttle, the defect will be quickly revealed, and when one shuttle is true'd up it is essential to deal similarly with both shuttles of the loom. Although the truing-up of round or boat-shaped shuttles does not affect the lifting capacity of the stop-rod blade, yet if one shuttle is true'd up and the other neglected, it will be easily seen that both shuttles could not make contact with the picker at exactly the same height. Hence it is very important that both the shuttles used in a loom should be exactly equal as regards height and breadth.

If the box plates are a trifle loose, the shuttle may rebound and allow the blade occasionally to engage with the frog. Slight looseness of the sley sword or rocking-rail will cause the stop-rod blade to shake correspondingly and lose some of its lift. A loose spindle may easily cause banging-off, owing to the erratic course of the shuttle preventing it from reaching sufficiently far into the box. A loose frog will cause banging-off owing to its being tilted; the vibration of the loom also affects a loose frog adversely. The frog when bolted to the loom frame must have sufficient freedom to work backward and forward to allow the back brake to make contact with the brake wheel when the loom bangs off, and to allow the T-headed bolt fixed in the starting handle of the loom to push the frog and brake back again when the loom is restarted.

The Frog

If the bolt that secures the frog to the loom frame causes the frog to be too tight, the loom when banging-off will not have the assistance of the back brake to the same extent to deaden the concussion. The movement of the frog in the loom frame slot must be confined to a backward and forward movement only. In case of a loose fitting frog, the frog will tilt towards the outside of the loom on account of the construction of the frog itself, the outside of the frog being the heaviest, owing to its having the projection that makes contact with the T-headed bolt in the starting handle, and also to the whole outside of the frog being solid. A loose frog will therefore drop at one side as far as possible; but the inside of the frog will be raised, making one portion of the frog higher than the other: and as the raised portion is the dovetailed lip part, it will easily be seen how banging-off can occur owing to a loose frog.

The Stop Rod

Loose swell-pin brackets will permit the stop-rod blade to lose some of its lift when the shuttle is full up in the box, and thus the frog may not be properly cleared. This will also occur when the stop-rod brackets are loose and allow the stop rod to "dance" or vibrate when the loom is running. The bevel of the reed relative to the race plate (although no standard bevel exists among different loom makers) ought to be equal to the shuttle bevel and also to the bevel of the box backs. This bevel is usually about 88 degs. An incorrect application of a new sley to the sley swords, and the latter to the rocking rail, causes the sley to be twisted—with disastrous results during the working of the loom.

The Picking Band

The weaver can easily prevent banging-off by tightening the picking band, if the trouble is being caused by the band having stretched. To adjust the length of the picking band (assuming that the picking stick is correctly adjusted) work the sley over; and when the picker has reached the extent of its traverse on the spindle, it should be possible to place two or three fingers between the picker and the buffer. Provided that the stop-rod and frog on a fast-reed loom are maintained in good condition, generally nothing very serious will follow banging-off except wear and tear owing to the sudden concussion; but cases have been known of the teeth in new driving wheels being broken and ruined in a week owing to the backlash from the concussion of repeated banging-off.

The Swell Spring

The result of a swell spring being too weak, slack, or broken, has often caused a serious smash of yarn, or a "trap." Owing to either the end of the stop-rod blade, or the shape of the corresponding lip of the frog, or both, having worn round, many smashes of yarn have been caused owing to the stop-rod blade having jumped the frog. Case-hardening of the blades prevents the extreme edge from wearing round so quickly. Setting of the picking bowl too low, when there are other means of increasing the power of the pick, tends to cause the shuttle to be raised in its delivery from box to box; thus the top of the shuttle will make contact with the bottom part of the spindle stud, and banging-off results.

New Applications

Many a good tackler has been puzzled as to the cause of a loom banging-off after a new frog, or a new stop-rod, or both, have been fitted to the loom. The reason is that the new frog lip and new stop-rod blade make contact earlier than before, and consequently cause excessive "shuttle room" (that is, the space from the fell of the cloth to the reed when the blade of the stop-rod is in contact with the frog); and if the pick be not sufficiently smart to deliver the shuttle into the opposite box before the stop-rod and frog engage, banging-off occurs. The same thing will happen in case the frog to brake connecting rod is too short. When fitting a new stop rod, or a new frog, the "shuttle room" can be ascertained by

placing the shuttle in the shed and turning the loom towards the front centre until the yarn is only just tight on the shuttle. If the pick happens to be too strong from the off side of the loom, or the check strap too long at the starting side, the shuttle would not only rebound at the starting side, but the pick of weft might be so slack as to fail to lift the weft fork—thereby stopping the loom before the weft was broken or run out.

Box Adjustment

A fault of some tacklers is to push the cloth end of the box front too far inwards to obtain sufficient lift over the frog, but such an adjustment wedges the shuttle in the box, thus requiring additional power for picking. Another fault is setting the delivery end of the same box too wide, whereby the shuttle is caused to rattle as it enters the opposite box, and an otherwise unnecessarily harsh pick is required. A shuttle which is too free in the box will cause banging-off, either by rebounding on one pick, or by not lifting the stop-rod blade high enough on the same pick. If the crank shaft wheel, or bottom shaft wheel, are loose in any way, or if either the top or bottom shaft cannons are badly worn, a false pick and banging-off will occur at times. Even if the nuts be screwed up tight with the screw key, and the keys that should secure the wheels to the shaft be too slack, the loom will be liable to bang-off, though the wheels may only have a trifling amount of play.

Shuttle Race

An erratic course of the shuttle has sometimes been caused by the race-board "springing" a trifle, owing to its having been nailed down instead of screws being used in conjunction with countersunk holes. An insecurely held reed in the sley, owing to the grooves in sley and sley cap being too large, contributes to the shuttle back wearing rough and the loom banging-off. Should a picker be insufficiently gouged out for the reception of the shuttle tip, rebounding will occur unless the checking capabilities of some other part, or parts, of the loom are increased. If the picking band is too long, or too slack, the pick will be weakened. The use of insufficiently seasoned timber for shuttles is a cause of their becoming warped, followed by banging-off.

Power of Pick

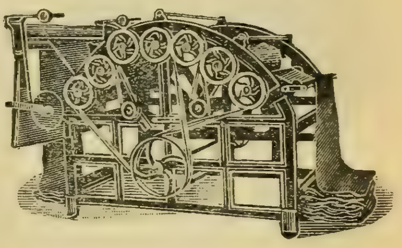
Increasing the power of the pick ought to be the tacklers' last resort when seeking to remedy banging-off, as such procedure increases the wear and tear of various parts of the loom, and looms so dealt with are always an increased trouble to a tackler. The pick should be such that the minimum amount of power is necessary to drive the shuttle from one box to the other. To enable this to be achieved, the checking of the shuttle must be given very careful attention, in order to ensure that no "jamming" or unnecessary checking force is brought to bear on the shuttle by the box plates and swell—otherwise increased picking power will be a necessity. The amount of power required to push a shuttle full up into the box can be judged by a practical tackler by his taking out the shuttle by hand and pushing it in and out of the box, taking particular notice whether an excessive amount of power is expended or not.

Shuttles worn thin at the back will fail to press the swell outwards far enough, or will rebound a trifle, and thus not raise the stop-rod blade over the frog. When using damp weft, a shuttle sometimes loses its shape and travels in a zigzag manner across the loom, which causes it not to reach the opposite box in time, or not enter the box far enough. A bouncing picking-stick is also very liable to give a false pick and result in the loom banging-off occasionally.

It will of course be understood that any of the foregoing causes may prevent the shuttle from being boxed properly, and make the loom liable to bang-off; or the latter may be caused by a combination of two or more of the causes given, the detecting of which often necessitates the tackler putting forth his very best efforts and judgment to put the loom in good working order again.

CLOTH: FINAL TREATMENT

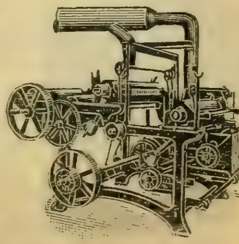
BRUSHING MACHINE.



Function. — To clean "grey" (or unbleached) cloth, and to remove from the surface thereof all loose ends, etc.; also to raise a slight nap on the cloth when such a finish is required. The surface of the cloth is thus made softer, and brought into better condition for the market.

Description.—The machine consists of three serpentine brushes and four emery rollers, with the addition of an ordinary plaiting-down apparatus at the delivery end of the machine. The cloth to be cleaned is simply guided under and over as many of the rollers and brushes as may be desired, according to the nature and strength of the cloth and the degree of cleaning and brushing it is required to undergo. If cleaning alone is necessary, the use of the emery rollers is discarded.

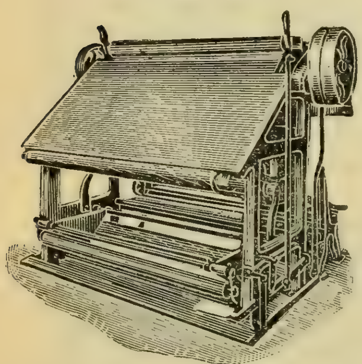
SHEARING MACHINE.



A result somewhat similar to that described above can be obtained by a process of shearing which is frequently applied to loom-state goods, *i.e.*, goods that are sold without subjection to finishing or other processes. The object is to remove projecting fibres, loose threads, and knots, and generally to brighten up and improve the appearance of the cloth.

In a machine for this purpose both sides of the cloth are first brushed, and then brought into close contact with the spiral knives of two shearing cylinders, which are enclosed in a casing. A strong air current is generated in this casing, which raises loose particles and brings them under the action of the knives, and also draws them away after cutting.

INSPECTING AND TRIMMING MACHINE.

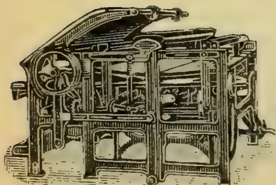


Function.—To examine and trim woven cloth after it leaves the loom, before it is passed on to the plaiting or folding machine to be folded in batches for the cloth press.

Description. — Is provided with a leaning table, three roller brushes, and a batching-off arrangement. The cloth rolls are laid in a cradle, which is placed in front near the bottom of the machine, whence it is passed over the table, whereon all face ends are removed. Then it is brushed on the face by a first and second brush, while the third brush acts upon the back of the cloth. The brushes have double rows of bristles, and are provided with boxes to catch the dirt and lint removed from the cloth. The machine is also provided with a reversing motion, so that the cloth may be run back over the table if required.

Pulleys.—16 in. dia. **Speed.**—50 revs. per minute.
Floor Space.—5 ft. 9 in. × 5 ft. 3 in.

PLAITING OR FOLDING MACHINE.



Function.—The plaiting of cloth into folds of given length, thus measuring it, and facilitating the examination by the cloth-looker.

Description. — The machine is provided with a folding table, constructed in circular form and arranged to rise and fall vertically. Across the front and back, extending from one side to the other, is a grip rail or retaining bar, the under surface of which is clothed with strong card wire. As the cloth enters the machine,

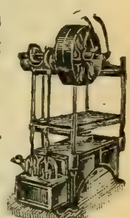
it is laid in plaits of uniform size, by the oscillating movement of a folding blade, the stroke of which can be adjusted to give various lengths of folds. The machine is usually provided with an index plate for recording the number of folds in the length of cloth folded.

Speeds—40 in. cloth......................72 folds per min.
50 in. cloth......................70 folds per min.
60 in. cloth......................65 folds per min.
70 in. cloth......................60 folds per min.

Pulleys.—10 in. dia. **Power.**—½ I.H.P.

Production.—One machine to 200 looms.

CLOTH PRESS.



Function.—After the cloth has been inspected by the "cut-looker," it is placed in this machine in batches of several folded pieces. It is then pressed tightly, and, while still under pressure, is secured with twine.

Description. — The machine is fitted with a top and a bottom table, one of which is stationary, and the other capable of moving vertically between strong upright guide rods. The movable table is usually actuated by a hydraulic ram, and the necessary pressure for the cloth or bundle is effected by the closing of the space between the two tables.

Speed.—80 revs. per min.

Pulley.—20 in. **Power.**—1 I.H.P.

Production.—One machine for an average-sized shed.

Floor Space.—6 ft. × 2 ft. 6 in.

Cloth Presses are also made with the movable table actuated by heart-cams, duplicated, and worked by powerful wheel gearing.

Speed.—60 revs. per min.

Pulley.—24 in.

Power.—¾ I.H.P. **Production.**—As above.

Floor Space.—As above.

Depressable Table.—To overcome the inaccuracy of folding the cloth on machines worked on the oscillating blade principle. Consists of two shafts, which extend across the machine underneath the table. These shafts carry brackets, to which are secured portions of what formerly constituted the ordinary curved table. The

shafts and the boards attached thereto are actuated by a small lever on either side. At the opposite end of each of the levers is a bowl or runner, which is free to work in sliding portions of two brackets secured to the machine framing.

So long as the bowls remain in the vertical paths of the brackets no motion is imparted to the levers; but immediately the bowls enter horizontal paths, the action of the table, as it is forced down by the accumulation of cloth, causes the centre-boards to fall out of line with the arc of the table. Thus the cloth is allowed to settle in the gap formed, which neutralises the defect hitherto existing. Lower vertical parts of the brackets keep the boards in position when the table is lowered for taking the cloth.

Horizontal Plaiting.—In this system a flat table is used, and the reciprocating movement of the plaiting knife is obtained by a link arrangement. The crank shaft carries a crank, on which is a pin that works in the vertical slot of a link. This link swings from two pendant rods, so that it receives a horizontal to-and-fro movement, and a very slight vertical one from the crank pin, owing to the arc through which the pendant rod swings. The arc through which the folding blade would otherwise travel is thus neutralised by these connections.

Rope Tyres.—Are for the wheels of trucks used in conveying warp and cloth beams, bobbin baskets, etc., from one department to another. They are noiseless, and they do not injure the mill floors. The peripheries of the wheel blocks are provided with holes through which the ends of rope are threaded and knotted. The remaining portion of the rope is wound round in a coil until the surface is covered, whereupon the opposite end is passed through the last hole and secured by knotting.

STANDARD WEAVES FOR COTTON GOODS.

Standard Weaves employed for cotton goods are given herewith, and may be briefly described as follows:—

Plain, Calico, or Tabby Weave:—

When woven with warp and weft approximately equal in number of threads and counts of yarn, the fabric has a plain even surface, and in this manner is produced a large variety of cloths, which differ only in respect of number of threads and yarn counts. Fancy effects are obtained

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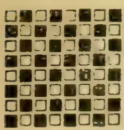
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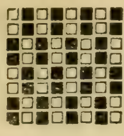
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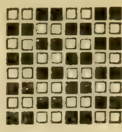
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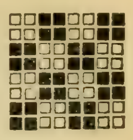
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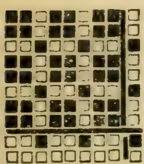
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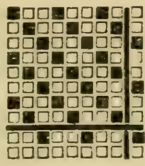
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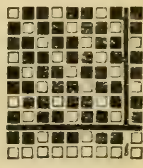
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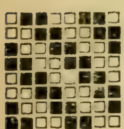
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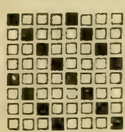
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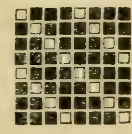
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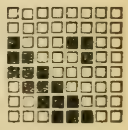
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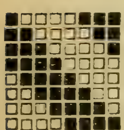
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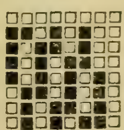
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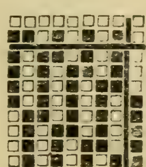
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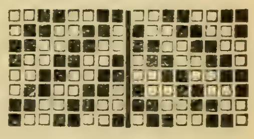
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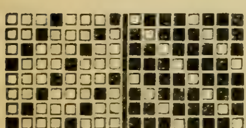
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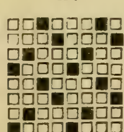
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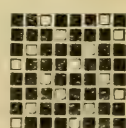
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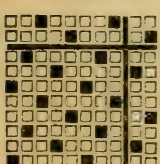
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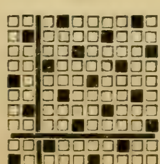
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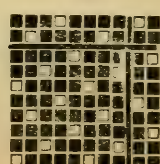

by varying the tension of the warp threads as in "crimp stripes" and "imitation repps." In the former case, tight and slack threads are arranged in stripe form; in the latter case, tight and slack threads are placed alternately. Cord stripe and checks have coarse threads in the warp, or in both warp and weft.

When the warp and weft threads differ considerably in number and thickness, "Cord" effects are produced —as in poplins and repps. Poplins have a large number of ends of fine counts, and a small number of picks of coarse weft, interwoven exactly as in Pattern 1. Frequently, however, Pattern 2 is used, with a finer weft, to produce a poplin, there being two picks in a shed. The true repp is a plain weave, with warp and weft arranged 1 thread fine and 1 thread coarse, the coarse warp thread always being lifted over the coarse weft thread, thereby producing prominent transverse ribs or cords. Imitation repps are also produced by interweaving the threads of a warp arranged 2 coarse, 1 fine, with a medium count weft, and using Weave No. 5. The fine warp is separately beamed and tightly weighted.

When weaving Plain Grey Cloths, it is usual to have the back warp roller of the loom fixed at a higher level than the breast beam, which causes the top line of warp threads to be slack when the shed is formed. Such threads then spread themselves midway between those of the bottom or tight threads, and thereby neutralise the tendency of the pair of threads in each dent to run closely together and form what is known as "reedy" cloth. Cloth with the threads evenly spaced is said to be well "covered."

Designs 2 and 3 produce Transverse and Vertical Cords respectively, the former requiring a greater number of ends than picks, and the latter the reverse conditions.

Design 4 is the 2-and-2 mat, dice, or Hopsack Weave; common qualities of Mattings are also woven with Design No. 3, using weft twice as thick as the warp and half as many picks as ends per inch.

Twills in large variety are employed for cotton goods, and only the more important small weaves are given.

Owing to the direction of twist in ordinary cotton yarns, the twill lines are bolder when they run from right to left, as in the designs given. When twills from left to right are required, it is usual to have the weft spun twist way.

Designs 5 and 6 are the 3-shaft: Jean, Nankeen, Regatta, or Galatea Twill, with weft and warp faces respectively.

Design 8 is the 4-shaft, 2-and-2, Sheeting, Harvard, or Cashmere Twill. Designs 9 and 10, the Florentine Twill upon the same number of shafts. Design 11 is the 6-shaft, and Design 12 the 8-shaft Serge Twill. Designs 13 and 14 are 7-shaft and 9-shaft Corkscrew Twills. Designs 15 and 16 are Herring-bone Twills.

Satin or Sateen Weaves:—

Designs 17 and 18 are the 4-shaft satin or satinette, chiefly used in coloured shirtings. Design 19 is the 5-shaft weft face satin or sateen, with the twill running to left, and requiring the weft to be spun ordinary or weft way when the twill is required to be prominent; but if the latter is to be broken or subdued, twist way weft would be used. Design 20 is the same weave with the twill running towards the right, and requiring twist way weft for a bold twill, or weft way weft for a subdued or broken twill. Design 21 is the 5-shaft warp satin or drill. Designs 22 and 23 are 6-shaft satins with weft faces; Design 24 is the 8-shaft satin or Venetian.

Honeycomb Weaves:—

Design 25 is the 6-by-6 honeycomb, weavable on 4 shafts of healds; 26 the 8-by-8, weavable on 5 shafts; 27 the 12-by-12, weavable on 7 shafts—all with point or centred drafts. In each case the cloth should have about equal numbers of ends and picks per inch to give good effects. For common qualities wherein the number of picks per inch is considerably less than the number of ends, Designs 28 (6-by-4) and 29 (8-by-6) are used.

Designs 30, 31, and 32 are Brighton honeycomb weaves on 8, 12, and 16 ends and picks respectively. No. 33 is a 10-end Sponge weave.

Huckaback weaves on 10-by-10 and 10-by-6 are given by Designs 34 and 35.

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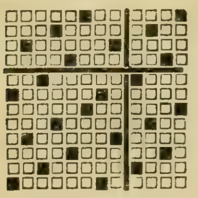

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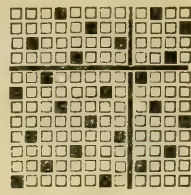

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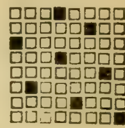

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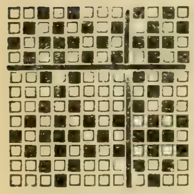

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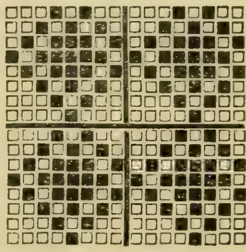

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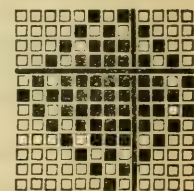

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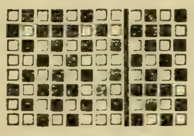

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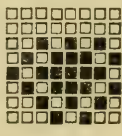

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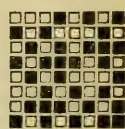

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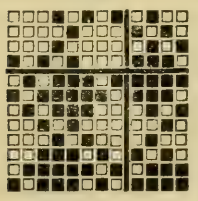

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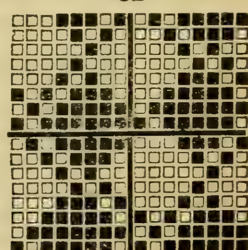

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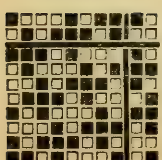

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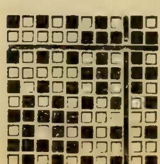

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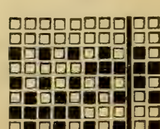

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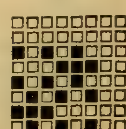

Mock Leno Weaves:—

Design 36 is the 6-end or 3-and-3 Mock Leno.
,, 37 ,, 8-end or 4-and-4 ,, ,,
,, 38 ,, 10-end or 5-and-5 ,, ,,
,, 39 ,, 5-and-1 ,, ,,
,, 40 ,, 7-and-1 ,, ,,

The denting of mock leno weaves is important when used as ground weaves for figured patterns. Design 36 should have three ends in every dent; 37, four ends; and 38, five ends in every dent; but for stripes wherein the open effect is required to be prominent, the denting

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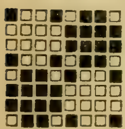

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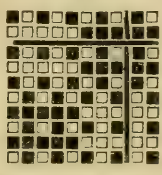

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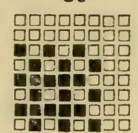

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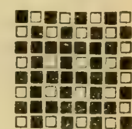
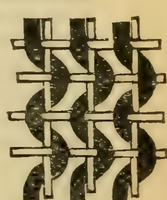


of 36 should be three ends 1 dent, 1 dent empty; for 37, four ends 1 dent, 1 dent empty; and for 38, five ends 1 dent, 1 dent empty. Design 39 should be dented five ends 1 dent, 1 dent empty; one end 1 dent, 1 dent empty. Design 40 should be seven ends 1 dent, 1 dent empty; one end 1 dent, 1 dent empty.

Gauze and Leno Fabrics.

These goods are woven by a method entirely different from that of plain and twill cloth weaving—inasmuch as the threads do not interlace in parallel lines, but are drawn out of their straight course, according to the design required. When woven, the fabric is open and firm, because the warp and weft threads when locked together make strong boundaries for the open parts.



Lappets

Are cloths figured by stitching extra warp threads into a ground cloth formed by the plain weave. Between each stitch the figuring or whip threads are moved sideways by needle or lappet frames, in such a manner as to form embroidery-like effects.

In Lappet Weaving the pattern or lappet warp is wound on auxiliary rollers, and is brought over a spring carrier to keep it at the proper tension. From this carrier it passes through the open healds (avoiding the

eyelets) to needle-bars, usually four in number. These bars are furnished with the number of pins required for the pattern design. The bars, being attached to the sley block, make all the motions that the sley makes. Beyond this they are furnished with mechanism necessary to actuate them in their rise and fall, and to carry their lateral traverse the distance required for the formation of the pattern. A separate motion controls the shedding of the lappet yarn. The pattern is formed by the lateral traverse of the lappet yarn as far as it is required to go. When the needle-bar is depressed, the lappet yarn is not woven into the fabric. The pattern-wheel governs the figure made. On the reverse of the pattern-wheel plate are circles, which govern the floating of the lappet yarn to a greater or less distance as required.

Pile Fabrics.

When the pile is intended to be produced by the warp, two sorts of warp are necessary—one for the ground or body of the fabric, and one for the pile. This arrangement admits of the production of two distinct kinds of fabric—namely, plush and terry pile goods. In the former the loops of the pile are cut; in the latter they are left uncut. Sometimes only a portion of the pile is cut, the uncut part being left to produce a figured effect.

Velvets and Velveteens.

These are generally woven with warp of two-fold yarns, and a large number of weft threads. The latter are of two distinct kinds, one of which forms the ground pick and the other the pile pick. The ground pick may be inserted every 2nd, 3rd, 4th, or 5th pick as required; the pile pick passed over from three to nine warp threads, then under one, so as to form a "float" of weft on the surface. Either a plain or twill back can be produced in the fabric, according to the interlacing of the ground pick.

Twill backed velvets are known as "Genoa" velvets.
Plain do. do. do. do. "Tabby" do.

Fustian and Velvet Cutting.

Preparation.—When the cloth has been woven, it next undergoes a process of stiffening by the application of size to the back of the fabric. This gives "body" thereto, binds the warp and weft threads together, and at the same time prevents the latter from being plucked out by the operating knife. The surface of the cloth

is next coated with a solution of "milk of lime," and left to dry. This operation answers a purpose similar to that of stiffening, and enables the knife to retain a keen edge and make a clean cut instead of producing a jagged surface. The floats of weft are not cut in the middle (as in silk velvet), but are severed slightly to the left, in the direction of the cutter. The term "to't" [to it] is applied to this proceedure. The process imparts a better appearance to the finished material, and accounts for the fact that a fustian properly cut rubs smoothly in one direction only. If the piece is cut on the "fro't" [from it] side (*i.e.*, to the right, or from the cutter), the pile lies very flat, and spoils the effect that ought to be produced with a high pile.

Cutting Frame.—The frame used for cutting the pile is about 2 yards long by 1 yard wide. The end of the piece is drawn over the frame and passed round a roller, which holds it in position by the aid of a ratchet arrangement fixed at the side of the frame. At the opposite end of the frame a strainer is fixed, which enables the operator to draw the fabric to such tension as shall allow the knife to be pushed along the warp, after the point has been inserted under the float.

To prevent the wood of the frame from wearing, a bevelled straight-edge is fixed at the far end, over which the cloth passes. Each run of the knife finishes at this straight-edge, so that a complete series of cuts leaves a definite line across the cloth for guidance in commencing the next lot of cuts. Any neglect in this respect causes a zigzag appearance in the fabric, which becomes very noticeable after dyeing and finishing.

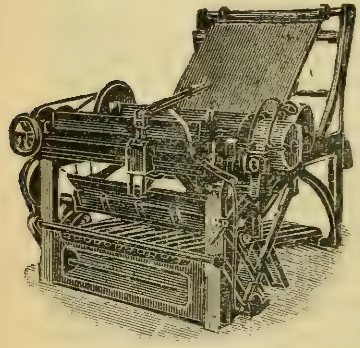
Common Velvets.—These are known in the trade as "slips," and are generally cut in pairs on the "long-run" principle, in which the frame used is about 13 yards long. This method cannot be practised with velveteens and the better-class velvets, because they contain more floats, and the necessary tension could not be obtained without damaging the fabric. In "slips" every alternate float only is cut—whereas in better-class goods every float is operated upon except for purposes of design. In cutting "slips" the operator has a piece of the cloth on either side of him; he cuts one while walking in one direction, and the other on the return journey, the pieces being arranged accordingly.

Corduroys.—Fabrics of this class are woven in the same way as velvets, except that the pile picks are bound by the warp so as to form straight lines of floats;

thus producing a ribbed surface. After weaving, the material undergoes (before cutting) the same stiffening and liming process as velvets.

Corduroys are made in many varieties—known as fine reed, eight shafts, thicksets, constitutions, cables, etc. Constitutions and cables have broad floats or races, which are some distance apart, and are usually cut by machines of two kinds.

(I.) This is provided with a number of circular discs corresponding to that of the races to be cut. These discs are mounted on a revolving shaft, and as the cloth passes underneath, the discs sever the float threads.



(II.) Consists of a specially formed knife supported in a movable holder, which is traversed laterally the distance from one cord to another, as each length of cut is completed. The cloth to be cut is presented to the knife at a convenient angle, and is caused to meet the edge of the knife by means of revolving rollers, round one of which it is wound as the cutting proceeds. The machine has an automatic stop-motion, which operates immediately a fault is made.

A "BEER."—Twenty dents in a reed, or 40 threads of the warp, constitute a "beer" in weaving.

Seamless Bags.—Looms employed in weaving seamless bags are usually fitted with a single-lift positive dobby. Four cards only are required in the manufacture of the bags. These have two rows of holes, one of which is used for measuring the body of the bag, and the other for weaving the solid (otherwise "condensing" the two cloths into one) to form the bag bottom, which is thus greatly strengthened at this point. The bag is automatically measured by the loom in the weaving, and the bottom is woven in the same manner. The bag can be made any length by means of change-wheels. In forming the body of the bag, the loom weaves two fabrics, one over the other; and in weaving the bottom these are combined into one. At this latter period the tension of the warp threads is changed.

COTTON FABRICS: GLOSSARY

Alhambra (See Quilts)—

Angola—
Plain or twill coloured shirting cloth; woven with a cotton and wool mixture weft.

Apron Checks—
Plain woven coloured cloth, used for aprons, and having a solid, striped, or checked body, and a side border comprised either of bold stripes or checks, or of figuring worked on the dhootie principle.

Back Cloth—
A re-inforcing cloth, used in calico-printing to support the fabric being printed.

Backed Cloth—
A single texture with extra threads, of either warp or weft, stitched to the back of the texture to increase its weight or bulk, in such a manner as not to interfere with the face texture.

Baffetas—
Plain woven cloth, bleached or dyed blue.

Baft—
The name applied on the West Coast of Africa to nearly all classes of cotton goods, both plain and coloured, when made up in short lengths, say 6 yards and upwards.

Baftas—
The South African name for a varied assortment of plain and fancy cloths, made up in 12-yard lengths.

Bandanna—
A calico cloth in which white or brightly coloured spots are produced upon a red or dark ground.

Batiste—
A fabric of French origin; the term has come to mean commercially a light, sheer cloth, made of a fine quality of yarns. A light fabric, with a Swiss finish in distinction from a nainsook, and usually wider and heavier than the latter fabric. In 32-inch widths and up a line of bastistes runs 14 to 16 square yards to the lb. There are bleached and unbleached cotton bastistes, also linen and coloured bastistes. The cottons are largely ecru, and the linen are most commonly in the grey.

Bedford Cords—
Fabrics having cords or ribs in the direction of the warp, produced by interweaving the weft, in plain or twill order, with alternate groups of warp threads. The ribs may be emphasised by the addition of wadding or stuffing warp threads.

Beige—
A dress fabric, generally twilled weave, made of yarns spun from wool, dyed in the stock; mostly sold in greys, and browns, and mottled or mixed effects. (See Vigoreux).

Boucle—
A definition the same as that for Bourrette applies to Boucle, except that in the latter fabric instead of the knot, in the dobby effect a loop is produced.

Bourrette—

A dress material, with dobby effect introduced into the body of the fabric in a pattern, the threads that form the dobby effect being hard twisted.

Brilliant—

A light dress cloth of fine texture, having simple spot figures on a plain ground; woven in dobby looms.

Brilliantine—

A printed or woven dress material, having a bird's-eye pattern woven into the cloth with jacquard loom, a calendar finish being usually given.

Brocade—

The ordinary cotton brocade is a figured fabric of single texture, having the ground and figure bound in any desired order, either uniform or irregular; jacquard machines up to 1,200 hooks are used, but simpler patterns may be dobby-woven. More elaborate brocades, used for dress and upholstery purposes, may have several wefts, in which case the cloth is one-sided, the warp forming the ground on the face, and the wefts appearing only where required to produce figure.

Brocatelle—

The real brocatelle is a rich upholstery fabric, which has a raised figure of silk warp and weft interwoven in satin order, on a ground formed by a linen weft and a special binder warp. The name is also applied to quilts having a coarse white weft and two colours of warp, which latter change places for figuring purposes.

Brown Sheeting—

Covers all weights of cotton goods in the grey or unfinished condition.

Brown Shirting—

The term is restricted usually to mean such grey cotton cloths as are from 40 inches in width and below.

Bugis—

A fine make of sarong, but having a border down one side only. The two plain edges are afterwards sewn together to give a very wide scarf.

Cabot—

A Levant term for a rather coarse make of plain grey cloth, woven from coarse yarns (about 20's counts), 12 threads of warp, and the same number of picks to the quarter-inch, and woven with "twist way" weft. Lancashire-made cabots are usually heavily sized, but pure-sized makes are also used for native dyeing. Considerable quantities of this cloth are made by South Carolina mills in 36 in. width, and shipped to China under the name of "American sheetings."

Calico—

In the trade has become a general term, and means practically any cotton cloth coarser than muslin.

Cambric—

A plain woven bleaching fabric, fine in the reed and pick, and made from cotton or linen yarns. Originally made at Cambrai, in Belgium. "Kid finished" cambrics are soft finished, and are used for dress linings.

Canton or Cotton Flannel—
A strong heavy twilled cloth, in either the grey or bleached condition, and raised or napped on one side.

Canvas Cloth—
Very strong plain woven cloth made from doubled yarns. Embroidery or Java canvas is an open perforated texture, generally having mock leno weave and well twisted yarns.

Casement Cloth—
A plain woven fabric, used for casement window curtains, and usually white or cream coloured. Made from mohair, alpaca, and cotton. The cotton variety is made from high-class yarns, well woven, and is mercerised before bleaching or dyeing.

Cashmere—
A fine twill dress fabric, originally woven from the wool of the Cashmere goat.

Cellular Cloth—
A plain leno fabric having an open cellular structure, which is specially suited for shirtings and underwear. A similar type of cloth is known as "Ventilette."

Ceylon—
A coloured stripe cloth, woven with cotton and wool mixture weft; used for shirts and underclothing.

Chadur—
A plain woven coloured check cloth, with a solid coloured border at one side only.

Chambray—
Ginghams either of solid colour or printed in stripes and checks upon a solid ground.
Also a light-weight cotton or linen dress fabric, weighing 13 or 14 yards to the lb., being a soft finished cambric.

Checks—
Fabrics having rectangular patterns formed by crossing the threads of a striped warp with weft threads of the same order. "Mock" checks are produced by combining weave effects.

Cheese Cloth—
A low count, light-weight cotton cloth, weighing nine to twelve yards to the lb. Also called Bunting.

Chelais—
A bordered cloth similar to a dhootie, but having a larger heading, and longer in length.

Cheviot Shirting—
A cotton fabric, either white or coloured, single or double thread, round or flat thread, and having a medium soft finish. Used for shirtings.

Chintz—
A printed cotton cloth, the characteristic feature of which is the bright and gay coloured patterns of flowers and the like printed upon the goods; used for many household purposes.

Chudders—
Shawls varying in size and style, according to the market for which intended, but having border, fringe, and heading.

N

Cleaning Cloths—(See also "Sponge Cloths.")
A term given to cloths used for cleaning machinery; usually made from cotton or spun silk waste, and of a coarse texture. They may be plain or leno woven; in the latter case the loom is provided with a special gauze reed, which dispenses with the use of healds.

Clip Spots—
Figured muslins ornamented by small detached figures of extra warp or weft, the floating material between the spots being afterwards clipped or sheared off.

Cords—
Simple cords are produced by running several threads of either warp or weft together in the weave. "Hair" cords are plain-woven, and have thick threads on a ground of fine warp and weft.

Corduroy (See "Fustians")—

Cottonade—
A coarse, heavy cotton fabric made in imitation of cassimere, for men's wear.

Coutil—
A strong three-shaft twill cloth with herringbone stripes, dyed drab and French grey and used for corsets.

Crape—
The crape fabric is plain-woven from hard-twisted yarns. The nature of the latter, together with subsequent finishing operations, causes a considerable contraction to take place, whereupon an uneven crinkled surface results. See also "Crepon."

Crash—
A coarse towelling fabric, chiefly made of linen, but also from waste cotton. Irregular weaves, such as the crape and oatmeal, are employed; these, together with the uneven nature of the weft, give a rough surface to the cloth.

Crepe de Chene—
A fabric produced from a fine silk warp and a worsted weft, alternate picks of which are twisted in contrary directions. A tendency to contract in opposite directions is thus set up during finishing, and the straightness of both warp and weft threads is disturbed.

Crepe Weave—
An interlacing of ends and picks in a more or less indiscriminate order, to produce an appearance of a finely broken character, usually associated with crape cloths.

Crepoline—
A fabric of a warp rib character, in which the regular order of the weave is so broken as to give a "rib crape" effect.

Crepon—
A structure of a crape-like character, which is obtained in several ways: (*a*) by combination of materials; (*b*) by weave combination; (*c*) by combination of *a* and *b*; (*d*) by mechanical arrangements during weaving; (*e*) by subjecting fabrics specially constructed to a special chemical process during finishing.

Cretonne—
A printed cotton material, chiefly used for draperies. Waste weft of an uneven character, and plain, twill, satin, and oatmeal weaves are used.

Crimps—

Plain woven fabrics, which have the warp threads divided over two beams during weaving. One of the beams is heavily weighted and the other only very lightly weighted. The threads of the latter beam are thus "taken up" more rapidly, and form stripes of a "crimped" or "cockled" nature.

Crinkle or Seersucker—

Names given to striped fabrics of the "crimp" type. Seersucker originally meant a silk fabric.

Crinoline—

Used at the present largely for stiffening ladies' dresses: A fabric made of horse hair and cotton, or of all cotton, and usually in width from 18 to 20 inches.

Cross-over—

Fabrics having stripes, of either colour or weave effect, extending across the width of the cloth.

Croydon—

A heavy make of plain cloth, bleached and finished to give stiffness and a glossy surface.

Damask—

A figured fabric, in which both ground and figure are bound by uniform weaves. Thus the ordinary linen damask has a figure of warp satin and a ground of weft satin of the same (or a different) number of threads to the repeat. The same is said to have been derived from Damascus, from which place the fabric was first introduced.

The foregoing may be described as the true damask; there is also a style of cloth, used for hangings and made from cotton or worsted yarns, which is really a brocade cloth, since both ground and figure are developed by irregular weaves.

Denim—

A stout 4-shaft warp-faced twill cloth, used for workmen's overalls. The warp is self-coloured, either blue or brown, and the weft grey; of coarse counts. The loom is set so that the warp will cover the weft on the face, and give a solid coloured surface.

Dhootie or Dhooty—

A grey shirting fabric, with fancy edges. Used by Hindus for loin cloths. The grey dhootie has merely taped edges, made by cramming grey or bleached yarn at the selvedges. The coloured dhootie has plain or figured stripes of extra warp threads, varying from half an inch to several inches in width, at the selvedges, and sometimes at intervals across the width of the piece. Special dobby machines or small jacquards control the figuring threads.

Diagonal—

The name applied to plain or figured twills of a bold [character.

Diamond—

The name applied to weaves of a diamond shape, also to the outside portions of bordered fabrics when such portion is filled up by a small repeating figure.

Diaper—

As applied to fabrics the name "diaper" describes two distinct styles, the first of which consists of a small diamond weave, while the second, and true diaper, has rectangular figures or dice which are interwoven on the damask principle. As applied to pattern or design the term signifies a small pattern which is repeated in a geometrical order over the surface to be decorated.

Dimity—

A fine reed cloth having stripes, in the direction of the warp, of four-shaft warp faced and weft faced twills. The warp twill assumes a raised position. Indian-dimity has cords woven into the warp or into both warp and weft.

Domestics—

A class of grey cloths, plain or twill woven, of medium and heavy weight, the better qualities being used for home consumption.

Domet—

A plain fabric similar to Canton flannel, but napped on both sides instead of one as in the latter cloth. Extensively used for shirtings.

Doria Stripes—

Fabrics having stripes formed by cramming the warp in the reed dents.

Double Warps—

The name indicates a good quality of various cloths made from a twofold warp yarn.

Drab—

The name applied to a nankeen cloth to denote the shade required.

Drills—

Strong heavy fabrics woven with three, four, and five-shaft twill and satin weaves, warp face. Sold in the grey with heavily sized warps, also bleached and dyed and in stripes. Largely used for suitings in hot climates. The Florentine drill or four-shaft drill is made from heavy yarns of good quality. The khaki drill for the Colonial market is usually of this make.

The Satin drill is made in a much finer reed than the other drills, and is chiefly bleached for the Far East and the East Coast of Africa.

The Pepperell drill is a grey drill of superior quality. It is made from high-class yarns and is exceedingly well woven.

Drillette—

This is a finer and lighter make of the drill type chiefly used for the home trade in the dyed and finished state. Linings and pocketing in 30 in. cloth for the Colonial markets are as a rule of the drillette make.

Duck—

A strong heavy fabric. One class of duck cloth is used for sails and is plain woven from doubled warp and weft; another class is used for men's wear in hot countries and is woven by the mat or hopsack weave.

Dungaree—
A workman's over-all fabric, similar in make to a denim, but woven with dyed weft as well as dyed warp.

Embroideries—
The name applied to a fine plain-woven cloth, used for embroidery purposes, and made from fine yarns.

Etamines—
A coarse, loosely woven cloth of cotton and wool, cotton and linen, linen or jute, silk and wool, or of hard twisted worsted yarn. The finished fabric has a network texture, and a popular use to which the fabric is put is to wear it in the form of a waist or skirt, over a gown of other material, perhaps a woollen, worsted, or silk gown.

Fents—
Short damaged lengths of cloths or short lengths cut from piece ends.

Flannelette—
A plain or twill fabric having coloured stripes or checks. Woven with coarse soft-spun weft and afterwards raised on one or both sides to produce a "nap" or fibrous surface similar to that of flannel.

Florentine—
A four-shaft warp faced twill much used for drills.

Fustian—
A class of strong heavily wefted fabrics, chiefly used for workmen's and riding suits, also in lighter makes for ladies' wear. In the principal variety the weft is flushed on the surface to form "races" or rows of floats which can be cut by a finely pointed knife to form a dense pile of the severed threads. In velveteens the pile covers the surface uniformly, similar to that of velvet; in corduroys the pile runs in straight lines or ribs, which may be of different sizes and have round or flat tops; these are known by such names as "thicksets," "constitutions," "cables," "round tops," etc. The heavier makes of both classes have twill backs and are known as "Genoa" backs; the lighted makes have plain backs, and are known as "Tabby" backs.
Another class of fustians has a raised "nap" on one or both sides, and includes "Cantoons" or "Diagonals" which have pronounced weft twills on the face side and are used for riding breeches; "Imperials,' "Swansdowns," and "lambskins" have weaves on the satin basis; while "moleskins" and "beaverteens" may be described as uncut velveteens of very heavy make.

Galatea—
Coloured striped cloths, usually 3-shaft, but sometimes 4-shaft, warp twill weaves. The stripes may be either simply coloured or dobby figured. Used for dress purposes and boys' suitings.

Gauze or Leno—
A light open texture of great strength in which warp threads twist wholly or partly round each other. Specially constructed healds termed "doups" are employed in weaving to permit of "crossing" threads, being raised first on one side, and then on the other, of "crossed" threads. The principle is also applied to jacquard harnesses to produce "leno brocade."

Garbardine .

Gingham—

A stout plain woven fabric, having checks of red, white, and blue; used for aprons, handkerchiefs, etc. Similar cloths having more variegated colouring are described as "checks." Madras gingham is distinctly a [sheeting fabric.

Glace—

A lustre fabric, sometimes of a figured character, made from a fine cotton warp and a comparatively thick mohair weft which is made to do all the bending.

Grandrelle (See Shirting)—

Granite—

A type of weave effect giving a broken, irregular appearance of a granite-like character.

Grenadine—

A transparent dress material of cotton, silk, or wool, or a combination, woven on the leno principle with a low reed and pick, or with the ordinary plain weave, in which case the weft is of a stiff nature, generally obtained by polishing.

Guinea-Cloths—

With reference to the Customs duty on cotton "guinea-cloths" (*guinées*) imported into the French West African Colonies, a French Customs circular (dated 1912) notifies that, in accordance with the views of the Consultative Committee of Arts and Manufactures, the following definition of the tissues in question has been adopted for tariff purposes:—"The category 'guinea-cloths' comprises tissues of cotton obtained *avec deux lames*, dyed in blue of an indigo shade, of a breadth not exceeding 91 centimetres, containing 18 threads or less in warp and weft in a square of 5 millimetres side, and weighing from 7 to 12½ kilos. per 100 square metres."

Hair-Cord Muslin—

Plain weave cloth, having stripes or checks formed by coarse threads.

Herring-bone—

A twill cloth or pattern having stripes formed by reversing the direction as well as the face of the twill when the latter is one-sided, see designs 15 and 16 on page 375.

Hickory Stripes—

Coarse coloured fabrics, in twilled stripes, commonly blue and white, and brown and white; used for shirts and pants in certain sections of the United States.

Honeycomb—

A weave which produces marked ridges and hollows, and thereby causes the surface of the fabric to resemble that of a honeycomb. See designs 25 to 32, on page 378. The term is also applied to leno weaves, when consecutive crossing ends cross in opposite directions.

Hopsack—

A mat or dice weave formed by running two or more ends and picks together. See design 4, page 375, which is the 2 and 2 hopsack or mat weave.

Harvard—

The name applied to coloured shirtings having the four shaft 2 and 2 twill (design 8, p. 375, as a ground weave; hence this twill is called in the coloured trade the Harvard twill.

Huckaback—

See designs 34 and 35, page 378. The short floats of warp and weft and the plain ground of these weaves gives a rough surface combined with a firm structure, which is particularly suitable for towelling fabrics.

Imperial (See Fustians)—

Indigo Prints—

A cotton cloth dyed in indigo; staple patterns are formed by the resist or discharge process.

Italian Cloth—

A lining fabric. Five-shaft sateen weave with a much greater number of picks than ends per inch, and woven with cotton warp and weft or cotton warp and mohair weft. Dyed and finished to give a smooth lustrous surface.

Jaconet—

A hard finished cloth, the weight of Victoria lawn, having a smooth, lustrous cambric finish. Also a soft finished jaconet that can hardly be distinguished from a heavy soft finished nainsook.

Jaconettes—

Plain cloths, about 20 yards in length.

Jean—

The name given to the three shaft twill designs 6 and 7, p. 375. When woven with a weft face and medium weight the cloth is largely used for linings. Woven with a warp face and strong yarns the cloth is sold as a "drill" and used for suitings, boot linings, and corsets.

Jeanette—

A 3-shaft weft twill having warp and weft threads about equally proportioned in number and thickness.

Kikoyes—

A shawl fabric, 39 to 48 inches wide, in lengths 70 to 90 yards, with fancy "heading" at each end and border each side; sometimes fringed.

Lace Stripes—

Cloths having openwork stripes of the mock leno weave.

Lappet—

A frame containing eyed needles which can be moved horizontally and vertically in front of the loom reed. Extra warp threads are passed through the needle eyes, and both are pushed through the warp before the passage of the weft to secure the extra threads into the ground cloth, which may be either plain or gauze woven. The frame is then returned to its original position, and moved horizontally a varying distance according to the outline of the figure required before entering the shed for the next pick.

Lawn—

A very fine plain, woven fabric. India lawn is a calendered fabric, about 12 yards to the lb. and 28 to 36 inches wide in book-fold or 40 inches in long-fold. Victoria lawn has a very stiff finish.

Leno—

See "Gauze." Mock or imitation lenos are ordinary woven cloths, that is, the warp threads do not cross each other, but the open effect is less pronounced, and the fabric is not so strong. See designs 37 to 40, on p. 379 In "net" lenos the leno or crossing ends are of two or three-fold yarn, and are crossed round a number of ground threads to give a lace effect.

Levantine—

A 4-shaft weft face twill cloth; used for linings and finished to give a glazed surface after dyeing.

Lining—

A fabric used for dress and coat linings, finished to give a smooth, lustrous surface. Woven from cotton warp and cotton, alpaca or botany worsted weft. The Italian is an example of the latter kind.

Long Cloth—

A plain or twill bleaching cloth used for the making of under-garments, and in lower qualities for export.

Loongyees—

Coloured check cloths, with self-coloured crammed edges of mercerised yarns. Used in the East for scarves.

Macana—

A fine, plain woven, coloured check cloth, high in the reed and pick.

Madapollams—

A plain cloth with coloured headings in the centre. Usually 32 in., 48 yards, and about 12 by 12.

Madras Handkerchiefs—

Plain-woven coloured cloths, with large bold checks. The yarns are dyed with a loose top, and the cloth is treated with acids which cause the colours to bleed or run and give an imitation of native block-printing.

Madras—

A thin and light fine woven cloth, in plain and fancy coloured stripes, a distinguishing and essential feature of the fabric being the presence of fine coloured stripes. The goods are used extensively for shirting purposes, and are frequently made up with Egyptian cotton, while the stripes may be of silk.

Marcellas—

A fine toileting cloth of the piqué class.

Masalia—

A fabric of the weight of a medium English nainsook, with a smooth, nainsook finish, and having from the weave a moire or watered silk effect.

Matelasse—

A double or compound cloth used for vestings and mantles. It has a figured face, with the figures developed by a variety of weaves. Wadding weft is also introduced to give a raised or embossed appearance.

Medium—

The name given to medium qualities of domestic cloths.

Mexican—

A plain grey calico, usually 32 to 36 inches wide and 24 yards long; about 18 by 18 reed and pick, and medium-sized warps.

Moire—

A term applied to the watered or clouded appearance obtained by displacing or flattening threads by the pressure of engraved rollers. Moire antique is a figured silk used for waistcoats and dress materials.

Moreen—

A repp cloth woven with coarse polished cotton weft, and afterwards treated for the production of moire effects.

Mull—

A plain weave fabric woven from very fine yarns. The finish is very soft and free from stiffening. China or silk mull is a light plain union fabric of cotton and silk.

Muslin—

A light open plain woven texture used for summer wear. It may be figured by lappets or by embroidery. Hair and crammed muslins have stripes of doubled warp yarn. Book and tarleton muslins are fine qualities for home-trade use.

Nainsook—

A light cotton cloth, may be plain, striped, or plaided. and from 30 to 31 inches wide. The English goods have a soft finish, while the French nainsook has a calendered finish. A bastiste and a nainsook can be made from the same cloth in the grey, the essential point of difference in the two finished fabrics lying in the finish. The English nainsook comes in varying weights from 10 to 14 square yards to the lb. The French nainsook is used extensively for such purposes as apron strings, strings to infants' caps, etc.

Nankeen—

The original Nankeen fabric was produced in Nanking in China, and was woven from a natural-coloured yellow cotton. As produced in Lancashire, the cloth is a closely woven 3-shaft twill, dyed yellowish drab and other colours, and used for stay and corset making and for pocketing.

Node—

A dress material of the bourrette and boucle order, a distinguishing feature being the effect produced, in the weaving, by the introduction in the weft or warp threads of a small bunch of yarns twisted together.

Oatmeal—

A cloth with an uneven surface, obtained by the use of an irregular weave. The grain-like surface is emphasised in lower makes by the use of coarse waste wefts.

Organdie—

A plain or striped cloth woven from superior yarns and finished with a stiff, glossy finish. When striped the weaves are plain and satin, the threads of the latter being coarser in counts and crammed in the reed to give a dense surface.

Orleans Linings—

A lining cloth having cotton warp and worsted weft

Osnaburg—

A coarse coloured stripe and check fabric, largely used in the southern parts of the United States for plantation purposes.

Oxford Shirting (See Shirtings)—

Padded Back Linings—

Fancy waist and skirt linings are sometimes printed black on one side, or backed, to prevent the printed pattern on the other side from showing through. A natural back lining is a solid coloured lining printed on one side.

Palembangs—

Cloths similar to sarongs, but slightly different in the lengths and heading pattern.

Panung—

The nether garment of the Siamese people. Made from cloth of the papoon style, or from woven or printed checks.

Papoon—

A plain woven cloth having warp and weft of different colours: thus the warp may be solid red and the weft solid blue; also woven in two and two checkings.

Paramatta—

A thin fabric composed of cotton warp and a botany worsted weft interlaced 2 and 1 weft twill. This cloth is used for waterproofing purposes.

Percale—

A closely and finely woven French cambric, round thread. The goods contain more dressing than ordinary muslin, but lack the glossy finish of dress or lining cambrics. The goods may be white or printed.

French Percale—

The genuine is made in France, and is a fine percale of good body. The so-called French percale signifies a similar fabric made elsewhere, and runs usually from 30 to 36 inches in width.

Percaline—

A fine linen or cotton cambric, usually of plain weave, used for shirtings and dress goods, and having a high glossy finish. The goods are frequently well loaded with starch to stiffen them. Percaline is lighter than percale.

Pique—

A fabric having transverse ribs or welts, which are produced by stitching tightly weighted warp threads through a fine plain woven cloth, which has its warp lightly tensioned. The face cloth is thus pulled down at the stitching points and the unstitched portions assume a raised or embossed-like appearance, which may be emphasised by the introduction of wadding weft. By varying the lifting of the stitching ends instead of lifting them in a body, we get the toileting figure. Piques are used for dress fabrics, children's wear, and neck wear.

Plush Velveteen—

A velveteen having a deeper pile; made by increasing the length of float or flush of the weft.

Pongee—

A fine plain-woven cloth, mercerised, dyed, and schreinered, to give a soft handle in imitation of the real pongee, which is a silk fabric.

Poplin—

A plain weave fabric originally made with a fine silk warp and a comparatively thick gassed worsted weft, which produced a fine corded effect. It is now made from cotton warp and cotton or worsted weft.

Printers—

Plain woven cloths used for printing chiefly, but also for export. Made from pure yarns of good quality and well woven. Burnley Printers or "Lumps" are usually 32 in., 116 yards, 16 square, *i.e.*, 16 ends and 16 picks to the quarter inch. Glossop or Cheshire printers are about 36 inch, 50 yards, 19 by 22 reed and pick.

Punjum—

A plain grey calico, similar in particulars to Mexicans, but usually 36 yards to the piece. The name is also applied to striped drills and checked plain cloths.

Quilts and Quilting—

The original quilting or quilted fabric was a bulky hand-made structure produced by placing a thick wadding between two pieces of finely woven cloth and stitching the whole together. The term is now applied to a variety of fabrics chiefly of a heavy type, and used for bed quilts and table covers. The principal styles of quilts now made include the alhambra, broché, honeycomb, grecian; toilet, marseilles, patent satin, and tapestry.

Alhambra quilts have a plain woven ground of thick white weft and a fine white warp which is controlled by healds and a tappet. For figuring an extra warp of several ends in a mail is controlled by jacquard & harness.

The Broché quilt has a warp of two colours arranged in end and end order; these change places to form ground and figure, and thus produce a solid warp face with the weft completely hidden.

Honeycombs and Grecians are single make and woven in the better qualities from three and fourfold warp and weft. The first-named has the honeycomb weave for a ground, and figures are formed of twill and satin weaves or differently sized honeycombs. Grecians have both ground and figure developed in twill or satin weaves, which give a smoother surface.

The Toilet or Toileting is a development of the pique principal, the stitching warp here being controlled by a jacquard harness whereby the stitching can be varied to produce figured designs. The face or calico warp is controlled by healds and a tappet.

The Marseilles quilt is practically the same as the original quilting, since it has two plain woven cloths with a wadding of thick weft between; threads from the bottom warp stitch the whole together and produce pattern of an embossed character, by the order of the stitching.

Quilts (continued)—

The Patent Satin—which has almost displaced the toilet and marseilles—has a smooth raised figure of coarse weft and a fine warp upon a smooth, even ground of fine weft and coarse warp, the latter warp being controlled by a harness and the former by a shaft mounting.

The Tapestry quilt is essentially a coloured cloth, having two colours of warp and several colours of weft, which may interlace in any desired order since the whole of the warp is jacquard controlled.

Regatta—

A coloured striped or check cloth woven with the 2 and 1 twill and generally with sized weft. Used for boys' suitings, washing dresses, and aprons.

Repp—

The true repp is a plain woven fabric having both warp and weft arranged, 1 thread fine, 1 thread coarse; the coarse ends are always lifted above the coarse pick, and thus produce prominent transverse ribs of a sharper nature than those of the poplin. Imitation makes are produced by weaving the weft from a single shuttle as design 5, page ~~347~~. 375

Rib—

The name given to any kind of cord effect; or to a weave in which either owing to the interlacing or to the yarns used, warp or weft is the stronger, and remains comparatively straight while the weaker does all the bending. Thus, in warp ribs, the weft is the stronger, and causes the warp to bend and form a warp surface rib running from selvedge to selvedge, while in weft ribs the warp is the stronger, and develops a weft surface rib running lengthwise of the piece.

Robes—

A name applied to printed twilled cloth, made from 64 square printing cloth. At one time produced in cashmere effects and worn for wrappers, whence the name. Now made in large, bright coloured furniture patterns and used for furniture coverings, curtains, comfortables, and such purposes. Furniture twills and robes are designated thus separately in the trade, though the uses to which they are put are the same. While both are twilled cloths, the term "robe" signifies that the fabric is made from a 64-square printing cloth.

Sarong—

A plain woven stripe or check cloth of brilliant colouring and elaborate capellas or headings. Used in the East Indies for scarves and loin-cloths. For the Southern Provinces the colours are generally required to be fast to light and washing, but the requirements in these respects are less exacting for Northern India.

Sarrie—

A garment cloth worn in the East Indies. Made in the form of shawls, with a woven or printed border at each side and a heading at each end.

Sateens—

Cotton cloths woven with weft faces for printing and lining purposes, and with warp surfaces for shirtings.

Satin—

As applied to fabrics the term originally described a silk fabric with a smooth even surface of warp threads. As applied to weaves the term describes a scheme of interlacements in which the intersections are evenly distributed and in such a manner that no two consecutive warp threads intersect with successive picks of weft. This gives the smooth, even surface mentioned above, and enables the intersections to be completely covered; the surface threads should be greater in number than the other set. A broken satin or sateen cloth has the warp and weft threads twisted in such directions as will neutralise the slight twill effect otherwise produced.

Satinet—

An imitation of the true satin in mercerised cotton or other yarns. Also the name given to the four shaft satin weave which does not fulfil the conditions of the real satin as regards order of intersections.

Scrim—

A loosely woven cotton material, often of fancy, lacy weave, its almost exclusive use being for drapery and window curtains. made of Hard twist yarns from the Voile idea

Seersucker—(See Crinkle.)

Serge—

A loosely intersected twill weave or fabric having broad lines. See designs 8, 11, 12, on page 375.

Slendangs or Pahoms

The real shantung is a native silk fabric. An imitation in cotton yarns has a special weft with thick, soft places at intervals.

Shirting—

The grey export shirting is a plain woven cloth of low quality and heavily sized warps. The home-trade shirting is stouter woven, of pure yarns for bleaching and also the calico weave. Coloured shirtings comprise a wide range of fancy stripes, checks, and dobby figures, mainly used for men's wear.

The Harvard shirting has a ground of 2 and 2 twill weave, and is closely woven with a moderate number of picks per inch.

The Oxford shirting has a ground weave of calico woven with two ends in a heald and one pick of coarse weft in a shed; this gives a softer feel than the Harvard. Basket Weave

Zephyr shirtings are plain woven in the ground, but from finer yarns of superior quality.

Sateen shirtings have a warp satin face weave with coloured stripes and much finer in the reed than the pick. Woven with dark coloured warp and weft the cloth is used for ladies' skirtings and boys' suitings.

Grandrelle shirtings are similar to sateen shirtings, but the warp is twofold yarn, made by twisting differently coloured threads together.

Tennis shirtings are of light texture and colouring with a fancy weave and yarns which give a soft full handle. They are sometimes raised on the back.

Sheeting—

This name is applied to two distinct makes of cloth. The first is used for ordinary bed sheeting, and is made in widths up to 120 inches, usually in a 2-and-2 twill, with coarse yarns to give a stout cloth, which may be sold either in the grey or bleached state. This is known as "Bolton sheeting." Waste sheetings are made from waste and condenser wefts, and the cheaper makes are often plain-woven. In the second case, the name denotes a grey calico cloth of about 36 inches wide, and slightly heavier in the yarns than the ordinary grey shirting.

Silesia—

A light lining fabric, twill or sateen weave; finished with a smooth glossy surface and printed in stripes.

Skirting—

Ladies' underwear material. In the finer makes of cotton skirtings the plain weave is used along with coloured stripe and check designs. The heavier makes include the sateen skirting mentioned above and also a class of "cross over" or weft stripes woven in circular box looms.

Skyteen—

A striped shirting cloth, woven with a light indigo-blue ground and a five-shaft satin weave.

Slendangs or Pahoms

Scarves or small shawls, made 25 to 30 in. wide, and 68 to 75 in. long. With "headings" at each end.

Splits—

Cloths woven two or more pieces in a width and cut apart either whilst in the loom or after removal. The inner selvedges are imperfect and are either hemmed by a sewing machine, or have the extreme threads worked on the leno principle to prevent ravelling.

Sponge Cloth—

See design 33. This weave gives a soft spongy fabric when woven with suitable yarns. Another kind of sponge cloth is used for cleaning purposes. In this case the leno weave (see page 379) may be used in conjunction with a coarse two-fold warp and a very thick waste weft. Another style is plain or tabby woven, and has waste yarns of about 12 hanks per lb. for both warp and weft.

Swansdowns (See Fustians)—

Tanjibs—

Lightly sized plain cloths, about 12 by 12 to about 14 by 14, with two lilac, red, and cord headings in the middle.

T Cloths—

Plain greys of low quality and heavily sized yarns, always in 24 yard lengths. The name is derived from the mark T of the original exporters.

Tarlton

Is coarser than organdie, and in the cheaper grades the meshes are so open as to be an approach to mosquito netting. The goods are made in colours, and are used for draping and decorating purposes.

Tartan or Scotch Plaids—

A check cloth, usually of elaborate design and colour scheme. It probably originated in the Highlands of Scotland, where each clan has its special tartan.

Thicksets—

A heavy fustian cloth, similar to a corduroy, but cut to give a heavy pile when dyed and finished.

Ticks or Ticking—

A strong heavy cloth used for bedticks. Woven in twill, herring bone, and satin weaves; often with linen and sized cotton weft to give strength and firmness.

Tollanette—

A plain woven coloured fabric, with variegated stripes across its width. The weft threads are greatly in excess of the warp, with the result that a solid weft surface is formed on both sides.

Turkey Reds—

Plain cotton cloths of good quality dyed turkey red.

Turkish or Terry Towelling—

A loop pile fabric used for bath towels and sheets. Two warps are employed in the weaving, the ground warp being tightly weighted and the pile warp very lightly tensioned. For two picks the reed gives way slightly as it approaches the cloth, but on the third pick it is held firmly and gives a full stroke, thereby sliding the three picks along the tight ground warp, and flushing the pile warp, which has been intersected by the weft, in the form of loops on one or both surfaces of the cloth.

Twills—

Weaves of a diagonal rib character. See designs on page 347.

Velour—

A cotton fabric used for curtains. It is the same on both sides, dyed in solid colours, and is woven with a coarse stiff pile.

Velveteen (See Fustians)—

Venetians—

Eight and twelve shaft warp faced satins with a large number of ends per inch. Afterwards mercerised, dyed, and finished to imitate heavy silks.

Vigoreux—

This differs from beige in that the yarns are printed before being spun, giving the goods an appearance like that produced by mixed yarns. Without close examination, it is difficult to distinguish whether the goods are dyed in the yarn or in the stock.

Voile—

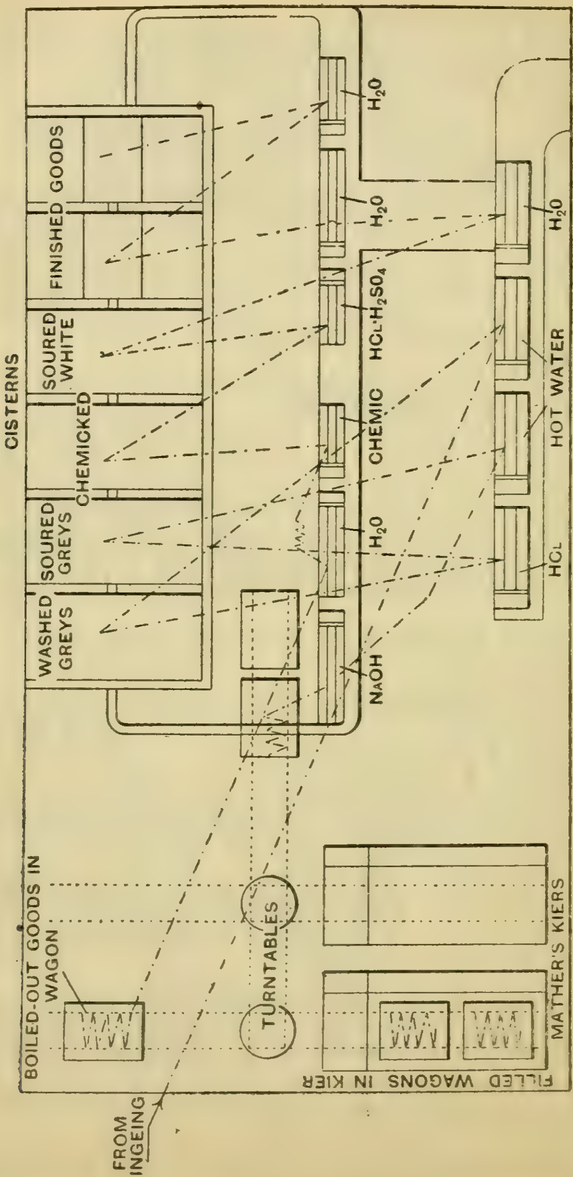
A soft transparent dress material, plain woven from cotton or wool yarns, which must be smooth and well twisted, and often ornamented by embroidered figures.

Wigans—

Plain or twill grey cloths, of medium quality and weight, used for domestic purposes and also for export.

Zephyr—

The name applied to plain woven fabrics of a light character, usually made from yarns of a good quality, and used for dress and shirt materials.



Sequence of Machines for Bleaching and White-Finishing Cotton Piece-Goods.—Showing one Machine for each step in the process. (Dash and dot lines show course of cloth.)

SECTION VIII:

BLEACHING

MERCERISING
DYEING, PRINTING
FINISHING
ETC

BLEACHING

The bleaching of cotton materials is nowadays carried out at all of the usual stages of manufacture—those of raw cotton, slubbings, rovings, cops, cheeses, hanks, and warps, as well as pieces.

By far the greater quantity, however, is bleached in the woven state, though each of the other resources has its special recommendations for particular requirements. Cotton is bleached in the loose state in occasional instances for the preparation of absorbent surgical and general wadding and such like purposes; and in other instances for the preparation of gun-cotton, or simply with the object of cleansing it—as, for instance, in the case of dirtied waste, for the sake of reworking and for the preparation of viscose compounds. According to the purpose for which the loose cotton when bleached is designed, varying degrees of care are called for in manipulation, though for the most part the possibility of matting the fibres has to be guarded against.

Bleaching in the hank, warp, cop, and cheese forms, is done for the production of woven goods, sewing threads, crochet yarns, laces, embroideries, and similar fancy articles.

Bleaching Agents.—There are more methods of bleaching available than the time-honoured chloride of lime bleach, though it is still the most successful, considered generally with regard to cost and results. These, however, find application within very narrow limits, and on the grounds solely of special adaptability to unusual circumstances.

Instead of using the ordinary chloride of lime bath, on account of the impurities held in it, and also at times because of its over-energetic action, the comparatively pure and less energetic hypochlorite of soda is accorded occasional preference, as well as baths of chlorine prepared by the electrolytic dissociation of a solution of sodium chloride. Moreover, the employment of chlorine is not altogether indispensable, inasmuch as satisfactory results, relatively to the modest nature of the demands made, have been obtained with hydrogen peroxide, the peroxides, the perborates, and also with permanganate of potash cleared by bisulphite of soda. The matter of cost, in relation to efficiency, governs the selection.

Manipulation.—The method of working is subject to wide modification, according to the nature of the bleach-

ing agent employed, and especially to the state of the material under treatment; but substantially it consists in two stages—first the boiling-out, for the purpose of loosening or even removing the natural impurities, and second the bleaching of the fibre. In the case of loose cotton, cops, cheeses, and hanks, the first may sometimes be dispensed with, but with a corresponding sacrifice in the quality of the end results.

The boiling operation may consist in treating the material according to its form in becks, machines, open kiers, or closed high or low pressure kiers with boiling water, either alone or with the addition of various approved alkalis. Each course obviously has its own recommendations, and is dependent for application as much on the texture as on the amount of impurities and natural colouring matter prèsent in the particular form of material: cottons slightly natural-coloured, yarns lightly twisted, and fabrics lightly woven, do not call for the same course of treatment throughout as highly coloured, tightly twisted yarns, and heavily woven and sized fabrics. Experience has shewn, however, that for the production of as good a white as possible on both yarns and pieces great attention should be paid to the operation of boiling-out, and for this reason this should be accomplished in a closed low or even high pressure kier. It reaches the highest degree of importance when the production of what is termed a market white on piece-goods is under consideration.

Preliminary Operations.—Generally speaking, no regular form of preliminary preparation antecedent to the boiling-out operation is called for in the treatment of those forms of material other than cloth, with the occasional exception, of course, of steeping in water or in a lye once used, or of gassing, in the case of yarns, when called for, but for piece-goods there are many operations leading up to it.

Bleaching by Electrolysis.

In electrolytic bleaching, the initial liquor employed is salt water only. Through the liquor is passed a current of electricity, and the resultant product is sodium hypochlorite, which is neither acid nor alkaline in character. The liquid being neutral, the chlorine is held loosely to its base, so that upon introduction of vegetable fibre the chlorine is attracted by the colouring matter. The reaction is not instantaneous, but lasts about half-an-hour, varying in time according to the nature of the

material and the thoroughness of the boiling process. The regularity of strength is assured by mixing the salt and water according to measure, and testing the resultant brine by the hydrometer. A complete installation for carrying out the system consists of a brine dissolver, an electrolyser, and a stone tank for the bleaching liquor.

The electrolyser consists of a rectangular stoneware box divided by the carbons into some thirty compartments, each chamber having a hole at the bottom, and another at the side about two inches from the top; the first and last carbons in the set form respectively the anode and cathode. The electrolyser is placed in a tank, which is filled with brine holding about 15 per cent. of common salt in solution. As soon as the circuit is completed a lively effervescence commences in the cells, due to the evolution of hydrogen. This raises the level of the liquid inside the electrolyser, causing it to overflow through the openings at the sides, while it is replaced by fresh liquor entering through the holes in the bottom.

Uses.—Hypochlorite of soda is often preferred for the bleaching of fine counts of yarn, lace goods, and some partially-coloured fabrics.

BLEACHING YARNS.

The bleaching of small lots of yarn in dyehouses, for white or for dyeing in bright shades, and in manufactories for weaving, is necessarily carried out somewhat differently from the continuous treatment of large lots, since the same elaborate and conveniently situated mechanical arrangements are not at hand—on account of their cost in relation to the amount of material treated being not usually warranted. In any case the provision of a closed kier, preferably fitted with means for causing the circulation of the liquor during the treatment of the yarn, is necessary for the most satisfactory results in quality of white and in economy of steam. The use of an iron kier calls for care in preventing the formation of iron-stains on the yarn, especially when a new kier is to be used for the first time, and this is simply done by applying a thin coating of lime to the inner surfaces of the kier. The white-washing should be done periodically. It is beneficial to add a certain amount of alkali to the water in which the yarn is boiled, and in these circumstances no scum or dirt should be allowed to enter the kier. This observation calls attention to the quality of the water supply. With a soft

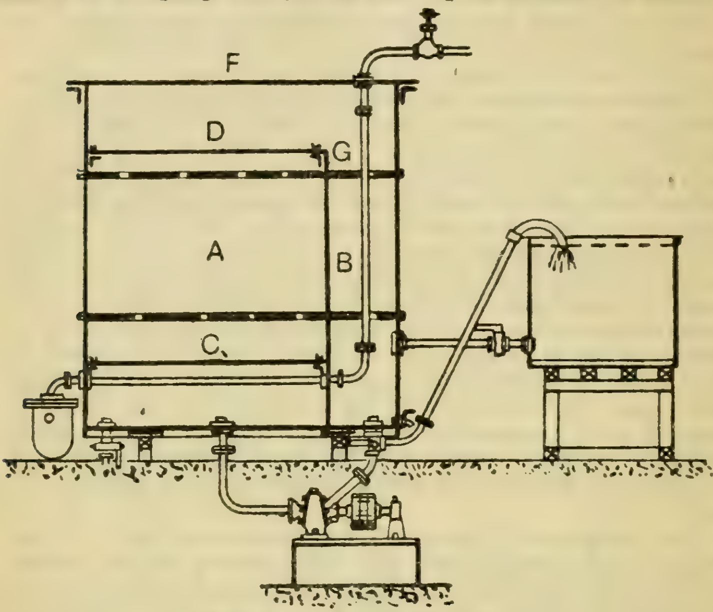
water no difficulties are encountered; but with hard calcareous waters, precipitates are formed upon boiling with alkali, and stains occur on the yarn. Condensation water is admirable for bleaching purposes, but since this too is liable to contain impurities (mineral oil), the water should be first boiled up with the requisite quantity of alkali in a separate vessel and the scum removed.

The proportion of the alkali depends upon the quality of the yarn: for 200 lb. of yarn, from 4½ to 9 lb. of calcined soda; or 2½ to 4½ lb. caustic soda; or 4½ to 9 lb. silicate of soda (52½ deg. Tw.); or a mixture of soda and silicate of soda. Care requries to be exercised in packing the yarn in the kier, and this operation should be done in such a manner that no spaces are left for the circulating lye to form channels rather than passing through the mass of the yarn. When evenly packed, the yarn is covered over with a sheet of hessian cloth, and rods of whitewashed iron are laid across to keep it in position. It is important that the yarn should be below the level of the liquor in the kier. After boiling-out, the yarn is washed well preparatory to chemicking, or even soured, and, of course, again well washed, according to the quality of the yarn and the degree of hardness of the water in use.

For souring at this stage a warm, weak bath of sulphuric acid is employed with soft waters, and of hydrochloric acid with hard waters. For the treatment with chloride of lime a stone cistern or a wooden vessel with a perforated false bottom is usually provided, coated with lead or cement. Besides chloride of lime, hypochlorite of soda is also used, especially for the fine and better qualities of yarn, prepared either electrolytically or by precipitating with soda from the chloride of lime solution. Chloride of lime is liable to form into particles upon mixing with water, and as this is to be avoided, special mixing cisterns, with mechanical agitators, are usually provided. The conveyance of the prepared bleaching liquor to the vessels where it is needed for use is generally accomplished by means of small centrifugal pumps of lead or phosphor-bronze, and lead pipes. Experience, however, has shown that it is better not to allow hypochlorites to come into contact with lead, but to use instead of lead (both for lining the vessel and for the pipes) either an alloy of lead and antimony, or porcelain.

In addition to the settling tank and the vessel in which the yarn is treated, it is advisable to provide

another—a mixing reservoir—so as to admit of catching the bleaching liquors for further use, after suitably replenishing. Solutions varying from ½ to 2 deg. Tw. are used for steeping the yarn; the liquid should be circu-



Bleaching Loose Cotton.

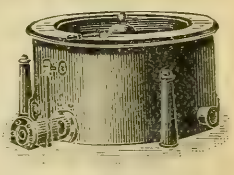
The vessel A is provided with a perforated bottom C, and a perforated cover D, which can be clamped down to the side G, the whole resting in the larger vessel B, which is itself closed in a loose cover F.

lated for a period ranging from two to five hours. At the end of this operation the liquor is either allowed to run away or is pumped into the mixing reservoir, and the yarn then thoroughly washed and soured; for cheap sorts of yarn and soft water sulphuric acid ½ to 1½ deg. Tw. should be used, and for fine sorts and hard water hydrochloric acid. The sours is first made up in a separate vessel, transferred to the vessel containing the yarn, and then caused to circulate for two or three hours. If any odour of chlorine is appreciable during the souring operation, it points to the fact that the preceding washing had not been thorough enough; and as the development of free chlorine in this way is liable to damage the fibre more or less pronouncedly,

immunity against trouble from this cause may be gained by adding to the sours a small quantity of a solution of bisulphite of soda. When the bleaching bath is composed of hypochlorite of soda this is not actually necessary, yet something is to be gained in the greater purity of the resulting white by giving a weak sours to the extent of about half the strength used when chloride of lime has been employed; with a very soft water, bisulphite alone answers satisfactorily. Some recommend thiosulphate of soda, but the bisulphite is to be preferred, since there is no precipitation of sulphur with its use, and it attacks iron-stains better. After the souring operation the yarn must be washed until no trace of acid is left behind, using litmus paper as the indicator. The washing is then continued on the machine, and is followed either by soaping or blueing, and finally centrifuging. Some importance is attached to the drying operation, and whether it be carried out on machines or in the stove, it is not usually advisable to allow the temperature to overtop 140 deg. F.

[For particulars regarding the effect of bleaching on the weight of yarns, see Index, under "Weights of Yarns: After Bleaching, etc."]

HYDRO-EXTRACTORS.



The removal of as much as possible of the absorbed liquor from the material is effected in the Hydro-Extractor, which, by centrifugal force, throws off all superfluous moisture, leaving the cloth somewhat dryer than would be the case with a good wringing.

Description.—The essential feature is an open-work wire cage, which can be whirled round at a tremendous speed; a metal case, and suitable pipes for collecting and carrying off the waste liquor thrown out; suspending pillars, to enable the machine to adjust itself in the case of unequal loading of the cage; and a small engine to drive the machine, this being both more convenient and better than driving from the mill shafting, as the machine consumes much power.

Speed.—1,000 revolutions per minute. **Power.**—10 H.P.

Production.—Baskets or cages made either 30 in. or 60 in. dia. **Floor Space.**—10 ft. × 10 ft.

Vacuum Hydro-Extractor.

The placing of piece-goods in rope form into centrifugal hydro-extractors is attended by certain disad-

vantages in the form of creases and sometimes worse damage. To avoid these, drying by vacuum has been introduced. The machine to carry out this process is furnished with a powerful cylinder air-pump, which creates a vacuum below an aperture over which the cloth passes, and thus draws the outer atmosphere through the fabric, carrying with it the moisture.

Drying Capacity—up to 12 Yards per Minute.

Space occupied by Machine: 9 ft. 4 in. × 4 ft. 10in. Height, 5 ft. 8 in. Ditto by Pump: 3 ft. 6 in. × 7 ft.

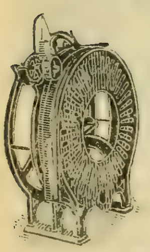
BLEACHING PIECE-GOODS.

With due regard to the texture of the goods, the manner of working cotton pieces depends upon whether they are to be bleached for printing, for dyeing with alizarine, or for a market white. The average qualities of cloths are worked in the rope form, while very heavy goods, such as moleskins, drills, and heavy twills, are most successfully bleached, even for dyeing, when treated throughout the several processes at full width. In the latter case, of course, special machines are required, particularly for boiling-out, for which a number of suitable kiers are in use.

Series of Operations.

(1) Marking and Stitching—

The pieces are joined end to end, so that the material can be put through the different processes continuously without entanglement and without incurring needless labour. For this purpose sewing machines of a special kind are employed. The thread used is of a soft nature, which will not cut the cloth even when passing between rollers under heavy pressure; and while the stitching will endure great tension, the threads can be easily drawn out when it is required to separate the pieces.



The machines employed are made to work by hand, treadle, steam, or electric power, and are invariably portable, so as to be readily removed from one place to another.

(2) Shearing and Moting—

Removes the loose fibres, motes, husks, and ends of yarn usually found on cloth as it comes direct from the loom. The shearing or cropping is performed by revolving cutters, which work against "ledger" plates. The cloth is then cleaned by rotary brushes, and an appar-

atus is provided for plaiting the material down ready for removal.

(3) Singeing—

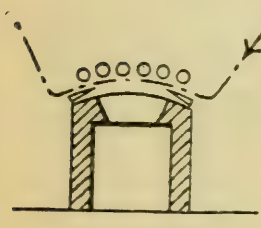
This preparatory operation may be performed by means of hot plates, hot revolving rollers, or by gas flame.

Hot Plate System.

The cloth is singed by being passed over the surfaces of two or more semi-circular plates, kept at a great heat by burning fuel—coal or oil. To work effectively, the whole surface of the plate should be utilised, and this is achieved by means of a traverse motion, which brings the cloth to bear momentarily on different parts of the plate surfaces.

Immediately after leaving the plates, the cloth should pass between a pair of nip-rollers to destroy the sparks, and the bottom roller should be partly submerged in water. It is also advisable to employ a steam-heated cylinder in front of the machine, for warming the cloth before it comes into contact with the hot plates.

Hot Roller System.



This is a modification of the plate system. Instead of passing the cloth over the fixed plates, it comes into contact with the surface of a copper or cast-iron tube, through which the fumes of the fire are allowed to pass, and which revolves slowly. This system is well adapted for singeing such pile goods as velveteen, etc.

Gas System.

Instead of passing over heated plates or rollers, the cloth encounters a gas flame. The cloth to be singed passes across a slot in the underside of an exhaust chamber, connected to a fan, while the flame of the burner is drawn gently through the cloth by the current of air set up by the fan. This system is considered the most effective, expeditious, and economical, and is strongly recommended by practical men. Gassing machines are also made specially arranged for the treatment of yarns.

———

With pieces, the foregoing are regular operations, and it is after singeing that variations come into vogue.

For the three classes named the following, though varied in many works, fairly represent the subsequent order of procedure:—

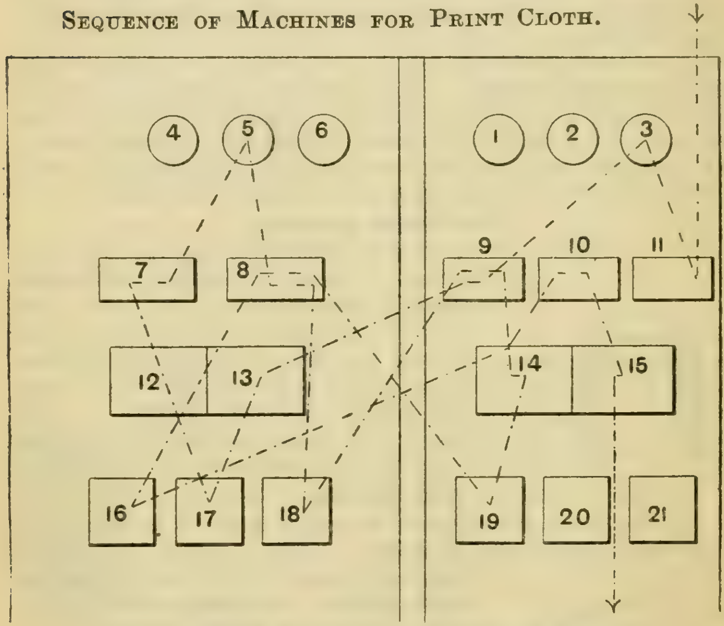
FOR ALIZARINES.

(1) Boiling in water.
(2) One or two caustic-lye boils.
(3) Soured and washed

FOR PRINTS.

(1) Steeping in sours (optional) and washing.
(2) Lime boil.
(3) Sours.
(4) Soda-ash boil.
(5) Chemic.
(6) Sours and wash.

SEQUENCE OF MACHINES FOR PRINT CLOTH.



(Dash-and-dot lines shew course of pieces.)

1, 2, 3, are Lime Kiers. 4, 5, 6, are Soda Kiers.
7, 8, 9, 10, 11, are Washing Machines.
12, 13, 14, 15, are Cisterns. 17 is HCl.
16 and 18 are H_2SO_4. 19, 20, 21, the Chemic.

MARKET WHITES.

(1) Hot water.
(2) HCl sours.
(3) Water.
(4) Caustic boil.
(5) Wash.
(6) Chemic.
(7) Sours.
(8) Wash.

(See Diagram, p. 400.)

Boiling Kiers.

The kiers are of two main types—the open and the closed—and are constructed in a variety of forms. Their efficiency depends largely upon adaptation. In both types the circulation is induced by boiling, or by the assistance of an injector.

The high-pressure (closed) kier was introduced many years ago, and with certain modifications since made it represents the main principle involved. In circulating, the liquor passes up a central pipe in the kier and is spread over the goods, and so on again. Just as in the case of open kiers, the lye is heated and brought to the boil by means of direct or indirect steam. Or an injector may be arranged to draw the liquor from the kier below its perforated bottom, to bring it into contact with the steam, and deliver it to the upper inside part of the kier. This suggests the attainment of a more regular circulation of the lye through the material in the kier, but the continual formation of condensed water causes a gradual dilution of the lye. On this account **pumps** were brought into use for causing the circulation of the liquor; and suction and force pumps combined are in use in some systems. Another improvement was the provision of a **superheater** in association with the kier, thereby making it possible to heat the lye indirectly and without diluting the liquor.

Some styles of boiling kiers are constructed with arrangements for providing indirect and direct heating, with fore-heater; the steam can by these means be streamed immediately into the liquor, and yet the latter may be heated under the false bottom indirectly, without the admittance of condensed water. By providing a central perforated pipe, perforated false cover and bottom, both in segments, and a strong pump, a further improvement has been realised, in that the liquor may be circulated first one way and then in the opposite direction through the material.

Cloth Piling Machine.

Function.—Dispenses with the practice of employing youths to pile the cloth in rope form as it is drawn from boiling kiers, etc.

Description.—The apparatus, which is supported from beams in the ceiling, consists of oscillating arms,

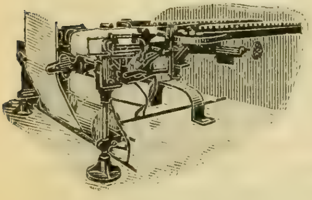
operated by cranks from driving gear arranged above. The arms carry a skeleton lagged roller, over which the ropes of cloth are passed and plaited down in convenient batches. The cloth as it leaves the kiers is passed through pot guide-eyes.

Roller Washing Machines.

The bleached cloth is passed through this machine in rope form. The driving of the squeezing rollers is usually by friction clutch and pulley, and provision is made for regulating the pressure put on by the top roller.

The Yellowing of Whites.—The yellowing of whites is a defect that occurs on bleached cotton goods after a period of storing. Technically pure cellulose retains its pure white colour an extraordinarily long time during exposure to light, but bleached cotton becomes yellowish in colour very quickly. The change in colour is attributed to the presence of compounds on the cotton, of an alkaline character, or of chlorine, acids, metallic salts, and soaps. Hence the necessity of washing thoroughly goods which have been bleached, and for the purpose of soaping only water that is free of lime and magnesium salts should be employed. The soap used should not be coloured and should be free of resin.

Cloth Feeder.—Dispenses with hand-feeding in guiding fabrics into bleaching, finishing, drying, etc., machines.



Consists essentially of two guiding sets, one for each selvedge, mounted adjustably so that they may accommodate different widths of fabric. Each guiding set comprises a pair of nip rollers, positioned at an angle so that the edge of the cloth passing between tends to creep outwards. One of these members is mounted to revolve upon a fixed axis, while the other is movable to press against its fellow. The pressure is controlled by the projecting extension of a piston that works within a small casing to which air is supplied by a suitable compressor. Should the edge of the fabric move laterally beyond the desired limit, it is brought into contact with a lever adapted to operate an air-exhausting valve in the casing referred to, whereupon the pressure or nip at the roller

surfaces is at once released, and the selvedge is momentarily free from or less affected by the spreading action, undue traverse being consequently counteracted. Although the pressure is ample for the effect, the exhausting lever is so sensitive that the lightest touch suffices to remove the nip, so that under these conditions the running cloth may be maintained in a practically undeviating line of travel.

BLEACHING OF COLOURED GOODS.

A very special branch of the bleaching trade is that concerned with the treatment of woven cotton goods containing coloured effect threads in the form of stripes, usually narrow, lengthwise of the cloth, and in the form of headings and borders. Among this class of cloths are shirtings, handkerchiefs, towels, nainsooks, and dhooties. Very great care is required in the bleaching of these goods so that the coloured portions shall not become adversely affected, and their successful treatment is a matter for the consideration of experts. Obviously the coloured yarns woven into these goods must necessarily have been dyed with colouring matters capable of withstanding a course of bleaching. Such colouring matters are somewhat limited in number, and those in use for the purpose are not altogether equal to resisting a full course of bleaching as the term is understood in relation to all-white goods. Yet there is a definite demand for the production of a white on these classes of partially-coloured goods that, as regards fastness to "yellowing" after storage, shall be quite equal in purity, clearness, and durability to the best of market whites.

These considerations make the work highly specialised, and more difficult than any other branch of bleaching. The course of bleaching through which the goods have to pass is simply a modification of the more severe method for whites, consisting, in general, in the employment of weaker solutions of alkalis and the other agents used, and in prolonging the treatment. This distinction marks the main difference. Then other modifications become necessary, according to the dictates of such controlling factors as the weight of the cloth, light, medium, or heavy, and the particular finish required on the goods.

In view of these important controlling factors it is not possible to state a method which is suitable all round. Broadly described, the modification of the white

bleaching methods consists in boiling in open or low-pressure kiers with milk of lime, and then with a dilute solution of soda-ash under similar conditions, and subsequently treating with much weaker liquors of bleaching powder and acid than are employed for ordinary whites.

Open kiers are much preferred to closed ones, and the operation of boiling in milk of lime and in soda requires, therefore, to be of longer duration for efficiency than is the case with the use of closed kiers. It may be stated that for the majority of coloured goods the closed kier, even the low-pressure, is seldom employed. The series of manipulations to which the cloth is submitted varies so much, on account of its texture and the finish required, that in some instances the lime-boil may be dispensed with altogether, whereas in others it is necessary along with more than one succeeding soda-boil.

The same factors may even call for a course of souring after the lime-boil or after the soda-boil, and again in some instances for chemicking and souring before the last soda-boil, followed again by chemicking. The process may therefore be either simple or complicated. The class of coloured goods known as dhooties, for instance, are of such a nature in texture, and the finish generally required is such, that the treatment given to these for the purpose of bleaching may sometimes consist merely in boiling-out through the machine, instead of the kier, with soda-ash, washing, boiling again, washing, chemicking, washing, souring, and finally washing thoroughly.

A more complicated course of procedure may have to be followed for the treatment of the finer and best qualities of dhooties and for other good qualities of partially-coloured goods requiring a good and comparatively permanent white. The procedure may consist of—

Impregnating with milk of lime.
Boiling in lime-kier for 10 hours.
Washing.
Boiling in soda-kier for 10 hours.
Washing.
Souring with hydrochloric acid.
Washing.
Boiling in soda-kier for 10 hours.
Washing.
Chemicking.
Washing.
Souring.
Washing.
Boiling in soda-kier for 10 hours.
Washing.
Chemicking.
Washing.
Souring.
Washing for finishing.

Testing of Chemics.—Many bleachers who realise the inaccuracies of the hydrometer test but require for practical use a quick and simple test of a fairly reliable

character, employ a standard solution of arsenious acid, prepared at such a strength that one drop of chemic of known strength will neutralise (say) 5 c.c. of the solution, and discharge the colour of the indicator (potassium iodide or indigo).

The chemic is applied by means of a graduated dropping-tube, or by even cruder methods, and the strength of the chemic is calculated as being inversely proportional to the number of drops applied.

COST OF BLEACHING.

The average amount of bleaching powder required for obtaining a full white on cotton is about 1 per cent., which incurs a cost to the bleacher of less than 7 pence per ton—an amount which, when compared with 7s. per ton in steam alone for each lye-boil, is insignificant (Knecht).

According to Theis, the materials and labour for a weekly production of 290,000 lb. of cloth are :—

4,290	lb.	caustic soda.
1,980	,,	bleaching powder.
704	,,	resin.
1,512	,,	hydrochloric acid.
6,380	,,	sulphuric acid.
10	persons	Grey-room and Singeing.
22	,,	Bleach-house.
6	,,	Drying.
1	Foreman.	
1	Store-keeper.	

Quantity of Water for Bleaching.—The total quantity of water required throughout the several operations connected with the bleaching of cotton piece-goods is very obviously a variable factor, and in making a computation only the lowest figure can be offered. Generally considered calculations may be made on the minimum basis of about 80 gallons of water per 110 yards of cloth weighing about 28 lb.

THE VAT DYES AND THEIR SUITABILITY FOR BLEACHING.

One of the most important developments in dyeing that has taken place since the introduction of the coal-tar colours, consists in the manufacture and application of what are termed the Vat Colours. This series possesses the general characters of extraordinary resist-

ance to bleaching—such, indeed, that many of the series will withstand unlimited bleaching, and very great resistance to light and washing. There are, of course, a few notable exceptions to these characters.

The two main classes of vat colours are known as **indigoid** and **anthracene,** but the differences are mainly concerned with constitution and manufacture rather than with the methods of application to textiles. Indigo itself has long been dyed in a "vat"—by which the dyer does not mean merely that a vessel known by that name is used, but that a particular process known as "reduction" is employed. This has for object firstly that of bringing the colouring matter into soluton, and secondly of converting it to a solution in which it can be absorbed by the cotton in such manner that the insoluble product originally dissolved in the vat may be deposited in its solid form in intimate contact with the fibres.

The reduction may be achieved in many ways after the manner of the several methods employed for indigo dyeing, but the usual and simplest method consists in sifting the colouring matter into a solution containing a little caustic soda and one of the preparations known as hydrosulphites. The colouring matter is slowly dissolved, and the tint of the vat is generally but slight, or may be quite distinct from that of the original dyestuff or the produced dye. The dyestuff is now in what is chemically known as the "reduced" condition, and in the case of indigo is known as the "leuco compound" or "indigo white." On removal of the yarn or cloth from the vat to the open air, this reduced dye absorbs oxygen from the atmosphere, and is thereby converted into a colouring matter substantially identical with the original dyestuff, but evenly distributed over and throughout the fibre. It may be said in fact that the reducing action of the vat takes oxygen out of the colouring matter, and subsequent exposure to air restores that oxygen. In order to complete the oxidation, various substances are used, one of the commonest being "chemic" or "bleaching solution." It will be obvious that if this bleaching solution is necessary for the formaton of the colour, further bleaching of the fibre by the dilute solution used in the bleaching of piece-goods is not likely to destroy that colour.

We see then that the vat colours are developed or improved by oxidation, but are rendered soluble by re-

duction, these two chemical processes being the opposite of one another, just as acidity and alkalinity are mutually opposed. Anything with a reducing action, then, will tend to cause the colour to run or "mark off," and in bleaching piece-goods containing vat colours we must obviously avoid such reduction. For this reason boiling with caustic soda must be avoided, and it must be remembered that this alkali when combined with the pectic and other impurities of cotton or with starchy matter forms a reducing solution or vat. Since caustic soda is often used in bleaching, it is obvious that the bleacher should be acquainted with the dyes he has to deal with: otherwise he may unintentionally cause marking-off. Owing to the fact that the vat colours are very resistant to bleaching solutions, the actual chemic treatment of the goods may be more severe than usual, and even the boiling with carbonate of soda may be dispensed with.

It is an extraordinary fact that the dyes which at one time were known as fast to bleaching (such as aniline black, indigo blue, turkey red, and chrome orange) are now greatly surpassed in this respect by vat colours. The vat black is undoubtedly far superior to aniline black, in respect not only of fastness to bleaching but in lustre, cleanliness, and freedom from tendering in process of dyeing.

Were it not for their greatly increased cost over older colours, the vat colours would have already supplanted them. In certain classes of bleaching goods the vat colours are used almost exclusively, but for dhootie borders they are making rather slow progress. The principal dye-makers supply vat colours, each maker excelling in a particular class or range of dyes, the leading makers being Bayer, Badische, Soc. of Chem. Industry in Basle, and Cassella; none of the British makers have yet seriously entered the field.

Not only are the vat colours used for goods that are to be bleached, but many of the dyes used for the "guaranteed fast colour" goods, now so widely advertised, belong to this class; and while it cannot be said by any means that a vat colour is necessarily faster than others, it is undoubtedly true that many of the members of the series are very much faster to light and washing than were the dyes formerly used.

MERCERISING

Cotton is mercerised with caustic soda while in the loose state, or as yarn, or in the woven form. Treating in the loose state is, however, practised but seldom, while yarns and cloth are mercerised to a very great extent.

YARNS

Mercerisation is carried out on yarns, for the most part in hank and warp form, and on pieces. The maximum degree of lustre is obtained under tension by the use of Sea Island cotton, and also well-selected varieties of Egyptian cotton, when combed in spinning and gassed before mercerisation. The shorter-stapled cottons, even good American grades, acquire a fair degree of lustre when they have been specially prepared. Most yarns, after being specially spun and gassed, are doubled, though single yarns are occasionally treated, with regard to the fact that the less the twist the greater the lustre of the yarn, and, of course, the better the cotton the less the twist that may be put in.

Twist in Yarn.

All yarns for mercerisation should be specially spun and doubled with the least amount of twist in that will answer the purpose for which the yarn is to be used. The less the twist, the greater will be the lustre of the yarn; and the better the cotton, the less the twist that may be put in. The following quantity of twist in yarn may be considered right for most purposes:—The yarn may be spun with four times the square root of the counts of twist in per one inch. If the yarn is 36's then—the square root of 36 is 6, and $6 \times 4 = 24$ twist in one inch. When 36's are doubled twofold the counts are

$$36 \div 2 = 18$$

and the square root of 18 is 4.243; this may also be multiplied by 4, and $4.243 \times 4 = 16.972$ = twist in one inch of 2/36's. Twist in 3/36's may be treated similarly.

$$3/36\text{'s} = 12 \times \sqrt{12} = 3{\cdot}464 \times 4 = 13{\cdot}856\ ;$$

13.856 is the twist in 1 inch of 3/36's. The quality of the yarn and the twist put in must always be sufficient to stand the great strain put upon it by the caustic soda bath.

Process and Principles.

The operation of mercerising includes three main phases:—(1) Impregnation of the material with the alkali; (2) washing; and (3) neutralisation of the alkali;

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and these are added to variously in almost all works to meet existing conditions. Boiling-out is generally the first step, although in occasional instances, when dealing with certain qualities of cloth, it is not resorted to. Hanks are boiled out under low pressure, while warps are passed through a boiling-out machine in the customary manner. Both forms of yarn are occasionally dried up after washing, before coming into contact with the mercerising liquor.

The principles involved in the control of the mercerising bath are the same for both yarns and cloths. They depend upon the temperature of the bath as well as upon its degree of concentration, and also upon the state of the material, wet or dry. When employed at a strength from about 42 deg. Tw. to 56 deg. Tw., and used regularly and continuously at the same strength, the temperature of the bath should not be allowed to exceed 30 deg. C. At lower temperatures the strength may be relatively decreased within certain limits. Generally considered, the duration of contact of the alkali with the cotton is regarded only as a matter of secondary importance, excepting in certain systems of treating pieces, when the contact is allowed to continue for many hours. For most purposes a treatment extending over two to five minutes is considered necessary to give the maximum of results.

The first washing is an operation as important as any, and should be accomplished while the material is still under tension. After this souring and washing follow, should the goods be finished or required for dyeing with any other colours than the substantive and sulphide dyestuffs. In the latter circumstances, and when the material is required for bleaching, souring is not carried out.

More or less effective machines exist for creating and maintaining the necessary tension. For most part these vary somewhat in each works, though automatic static, dynamo-static, and astatic contrivances are general. All these forms are in use for the treatment of hanks. Warps are most successfully mercerised by passing in the rope form through an adapted warp-dyeing machine of several compartments. The treatment is continuous. This form of yarn is likewise successfully treated at full width by passing through a slasher-like machine with a series of wide compartments.

Observations.—Yarns of certain qualities and for certain purposes are sometimes gassed after mercerisation as well as before, so as to enhance the lustre. The

gassing applied to yarns and the singeing to cloth should be carefully carried out, and burnt places or flame-marks avoided.

When dried in the stretched condition, mercerised yarns show an appreciably better lustre than when dried in the loose state. A course of stringeing on specially constructed machines, or such as are employed for the lustring of silk, is also occasionally resorted to. Except for the production of special finishes, it is most practicable to allow the bleaching operation on both yarns and pieces to follow that of mercerising.

Boiling.

Before mercerising, the yarn must be well boiled in a closed boiler for four hours at not more than 5 lb. steam pressure. It must then be well washed off in cold water until all impurities are cleared away, when it may be well wrung out or extracted. If for bleaching or dyeing, it is better to mercerise the yarn first.

Caustic Soda.

The caustic soda bath must be kept up to 60 deg. Tw. It need not be stronger, but a solution at 70 deg. Tw. must be kept at hand, so that, as the bath gets weaker with the wet yarn passing through, or working in it, it may be strengthened up, as is found by frequent testing to be necessary to keep the working strength at 60 deg. Tw. If the strength gets to 55 deg. Tw. the result will be very poor, and if to 47 deg. Tw. it will be of no use at all. Caustic soda can be obtained in solution of the strength required, or solid in cakes; 2 lb. 6 oz. of the latter will make about one gallon of solution at 60 deg. Tw. As caustic soda acts smartly on the skin, it should be well washed off the hands until all slipperiness is gone. Good aprons should be worn by the workpeople, or the splashes, if allowed to dry on the clothes, will make holes.

Tension of the Yarn.

Whether the mercerising is done in the hank or in the warp, the yarn must be kept at one tension throughout, and so spread out that one thread is not tighter than another. The secret of obtaining a silky lustre on cotton yarn is keeping it well on the stretch while in the caustic soda. It should be the same length after mercerising as in the grey, and must not be shorter—though it may be 2 per cent. longer without injury. The tension is so great when the yarn has got well wetted out in the caustic soda, that the bearings must be strong and well

fixed. Without this tension the yarn would contract one-fourth of its original length.

Five minutes should be allowed for the yarn to remain in the caustic soda bath. There is no advantage in prolonging this, though it might go to seven minutes. But to obtain like results the time must be always the same, and all parts of the yarn must be wetted alike.

The temperature of the bath must be kept always the same. The colder the better, say 60 deg. F.—no higher. If there is any difficulty in getting it down, ice must be used, so that it is the same all the year round, thus mak-and the results uniform.

Washing.

The yarn must be kept at a tight tension until it has been washed. As a good deal of caustic soda is carried away from the bath, the yarn should be washed first with a little water, which can be used for making up a new solution of caustic soda. A good wash with cold water follows, taking care that the threads do not get entangled. If any soda is left in the fibre it will cause further shrinkage and the yarn will lose some of its lustre.

If the yarn is to be used immediately for bleaching, or dyeing with certain dyestuffs, it need not be put through an acid bath.

Souring.

Souring-off is generally done in a bath of sulphuric acid at 1 deg. Tw. After souring, the yarn must be thoroughly washed. If the least acid is left in, the yarn will go tender, and, if subjected to heat, will become rotten. If a little water wrung from it after washing does not taste sour it will be all right. A running stream of water is good for the final washing. The yarn is then extracted and dried in a hot-air chamber, and it looks better if it can be kept gently on the stretch while drying.

When all the conditions necessary for good merceris ing have been fulfilled, the results will be always alike and the average strength of the yarn will be increased 30 per cent. It will also have a silky lustre, and will have gained appreciably in weight. Mercerising does not destroy the elasticity of the thread—it retains four-fifths of the elasticity of the grey.

BLEACHING AND MERCERISING YARNS:

Effects on the Goods.

(See also p. 441.)

In regard to the effect of bleaching and mercerising on cotton yarns, a series of experiments have been

carried out with the object of finding the effects of various treatments and the effect at different stages of these treatments on the yarn as regards length, weight, counts, breaking strength, stretch, twist, and moisture. Yarn was subjected to the following treatments:—Mercerising, bleaching after mercerising, and mercerising after bleaching; further, three different bleaches were used, namely, bleaching powder solution, sodium hypochlorite, and electrolytic bleaching. The table on p. 423 presents the results.

MERCERISING YARNS: EFFECTS.

Besides becoming lustrous during mercerisation, cotton goods increase in strength, and develop a greater affinity for dyestuffs and the absorption of moisture. The increase of affinity for dyestuffs is due to the following factors:—

(1) The action of the mercerising agent in removing such resists as wax, oil, and natural colouring matter, which are always present in cotton fibres.

(2) The modified physical structure of the fibre itself, causing the cell elements to become distended, and providing the fibre with a greater power of absorption and retention of liquids than when unmercerised, and in a flattened and twisted condition.

As the standard amount of moisture allowed in ordinary cotton is 8.5 per cent., a further allowance becomes necessary in the use of mercerised yarn. An allowance of 11 per cent. for moisture in mercerised cotton yarn is recognised in many quarters for commercial transactions.

Strength.

It is asserted that considerable difference is observable in the strength of cotton yarns and fabrics in a mercerised and unmercerised condition. An important feature in regard to mercerising is that the strength of the material is considerably increased. During the process of mercerisation it must be remembered that some shrinkage of fibre takes place. This fact, in addition to the fact that the fibre becomes more solidified and increases in diameter, accounts for the fibres of the yarn becoming more closely knitted together. The wax and oil substance contained in and on the untreated cotton fibre can be considered to act as a lubricant when the material is subjected to a tensile

	Grey	1	2	3	4	5
Average loss in Weight per cent.	0	5·53	4·61	3·02	3·03	3·06
Average loss in Length per cent.	0	1·95	1·00	0·375	1·11	1·14
Mean Count, Hanks per lb.	16·46	17·66	17·42	17·35	17·02	17·02
Mean Lea Break in lbs.	97·0	72·41	82·19	86·41	87·125	85·94
Mean Double Thread Break in ozs.	27·68	23·26	26·125	27·55	28·08	27·58
Mean Double Thread Stretch in $\frac{1}{16}$ in.	20·57	14·22	11·085	10·255	11·09	10·78
Mean Turns per inch.	20·18	19·88	19·57	19·99	20·205	20·25
Moisture per cent. as Regain	5·86	5·07	7·18	7·34	7·55	7·59

	6	7	8	9	10	11
Average loss in Weight per cent.	5·00	4·91	4·88	3·40	3·37	3·37
Average loss in Length per cent.	2·04	1·73	1·97	0·17	0·63	0·10 gain
Mean Count, Hanks per lb.	17·35	17·45	17·40	17·58	17·24	17·40
Mean Lea Break in lbs.	77·66	79·97	79·78	80·28	80·47	78·28
Mean Double Thread Break in ozs.	24·14	23·925	23·65	26·52	26·14	25·85
Mean Double Thread Stretch in $\frac{1}{16}$ in.	13·76	13·97	13·78	9·08	9·23	8·90
Mean Turns per inch.	20·07	20·11	19·895	19·91	10·32	19·59
Moisture per cent. as Regain	5·28	5·46	5·42	7·63	7·69	8·19

Column 1=Boiled; 5 per cent. caustic.
„ 2=Mercerised; 60 deg. Tw.; tension.
„ 3=Mercerised & Bleached (bleaching powder).
„ 4= „ „ (hypochlorite of soda).
„ 5= „ „ (electrolytic bleach).
„ 6=Bleached (bleaching powder).

Column 7=Bleached (hypochlorite of soda).
„ 8= „ (electrolytic bleach).
„ 9= „ (bleaching powder) and Mercerised.
„ 10= „ (hypochlorite) „
„ 11= „ (electrolytic) „

strain, and such conditions tend to assist the fibres to slip over one another. As the wax and oil are removed during the mercerising process, however, the friction between the fibres is likely to become increased, and, in consequence, the thread will further resist any strain applied.

The increased power of resistance possessed by a mercerised cotton yarn is entirely due to—

(1) The action of the oil and wax being eliminated.

(2) The greater cohesion of the fibres. To ascertain the degree of increased cohesion developed by mercerisation, an investigation has been made as follows:—A 2/80's and 1/40's combed and gassed Egyptian cotton yarn was mercerised for lustre. By means of the microscope the yarns and their fibres were measured for diameter, with the following results:—

Diameters of Fibres and Yarns before and after Mercerising.

	Fibres.			Yarns.	
Counts	Before	After		Before	After
2/80's	$\frac{1}{2040}$ in.	$\frac{1}{1940}$ in.	......	$\frac{1}{141}$ in.	$\frac{1}{160}$ in.
1/40's	$\frac{1}{1720}$ in.	$\frac{1}{1670}$ in.	......	$\frac{1}{126}$ in.	$\frac{1}{158}$ in.

The increased diameter of fibre was equal to 4 per cent., and the decreased diameter of yarn to 18 per cent.

An indication of the degree of increase in strength developed during mercerisation is illustrated in the following table:—

	8 in. Yarn Tested.			Average 20 Tests.	
	Strength.			Elongation.	
Spinner	Before	After		Before	After
A	$8\frac{3}{5}$ozs.	14ozs.	....	$\frac{5}{18}$ in.	$\frac{5}{16}$ in.
B	$9\frac{1}{2}$ozs.	14ozs.	....	$\frac{7}{18}$ in.	$\frac{7}{16}$ in.
C	$10\frac{1}{4}$ozs.	14ozs.	....	$\frac{6}{16}$ in.	$\frac{6}{16}$ in.

In this example, tensile strength tests were made before and after mercerising—of 2/60's combed and gassed Egyptian cotton yarn, supplied by three yarns, A, B, C. These yarns (although supposed to be identical in all respects) show some variation as to their power of resistance. Before mercerising, the yarn supplied by spinner A broke with an average load of 8 3/5th ozs., that from B at $9\frac{1}{2}$ oz., and that from C at a load of $10\frac{1}{4}$ ozs. After mercerising, all these yarns averaged a breaking strain of 14 ozs.

The difference in the strength of the grey (or unmercerised) yarns is due to the variation of cohesion of

the fibres in the respective yarns, while the uniform result after mercerising is due to the same cohesiveness having been reached in each case. That is to say, in each yarn the diameters of the fibres have increased and the diameter of the thread has decreased to whatever extent the conditions allow.

The condition of the fibres in the three yarns was such that increased cohesion of fibres developed during mercerisation to the extent that—

Yarn A	increased from	8 3/5 oz.	to	14 oz.
,, B	,, ,,	$9\frac{1}{2}$,,	,,	14 ,,
,, C	,, ,,	$10\frac{1}{4}$,,	,,	14 ,,

As the three yarns were subjected to identical treatment during mercerising, the results suggested that the limit of cohesion of fibre was reached in each case. Another notable feature in connection with these results was that—before and after mercerising—the elasticity or elongation of each yarn remained the same.

MERCERISING CLOTH.

In mercerising cloth, the material may be taken directly from the singeing room, or it may be scoured or half-bleached before going through the mercerising range. The latter course is recommended, because in the grey the cloth contains a certain amount of size, which has a tendency at times to neutralise the caustic soda. Moreover, when treated in the grey state, extra caustic soda is required to keep the bath to its proper degree of strength, which is more expensive than first scouring to remove the size. The latter system also ensures a more uniform finish to the goods after they have been dyed.

Stress of competition in the mercerising industry has paved the way for the realisation of all possible forms of economy in working, and great attention has been devoted to means for effecting the recovery of as much as possible of the caustic soda from the lye, because loss permitted there might be very great. Two or three types of apparatus have been in use for many years for concentrating the mercerising lye after use to at least a state of density suited for re-use, but these, on account of their initial cost, can only come into requisition in instances where a very large output is concerned. In such cases these apparatus have more or less earned interest on the capital laid out in them, but they do not effect the amount of economy that has been more and more demanded during recent years. Consequently various proposals, both of a mechanical and a chemico-physical

nature, have been brought forward, and in some cases have been adopted industrially to minimise the loss of caustic soda. Those of a mechanical order comprise, for the treatment of cloth, the provision of scrapers and rollers on the mercerising range to come into contact with the impregnated cloth previous to washing, thus removing before washing more of the strong caustic lye than formerly; another method supplies steam to the impregnated cloth in place of the first washing for the removal of the caustic, with the lesser possibility of unduly diluting the alkali. Another is a sort of suction device for extracting the alkali before washing. All these processes have secured practical application.

Other proposals are concerned with the particular form of treatment for the purpose of utilising the spent lye, which generally stands with the first wash-water at a density of 6 to 8 deg. Tw. Where the expense of concentration plants is out of the question (these instances are common), various suggestions have been made lately for the solution of the problem of cheaply and effectively recovering or utilising the alkali. Success has attended some of them. The problem loses some of its difficulty when bleaching is an operation carried out at the same works, for then the used lye may be utilised for the kier-boils, and some portion of it even for the manufacture of soap where large quantities of that product happen to be required. But there may be no bleach-house to consume the lye, or that department may not be large enough to take all of it.

Anyhow, one method purposes getting rid of the impurities which by partial evaporation of the lye necessarily accumulate, to obvious disadvantage, by boiling the lye with a mixture of lime and ordinary soda, thus precipitating the organic impurities and at the same time manufacturing caustic soda.

MACHINES.

Whether the material be treated in the yarn or woven state, the machinery employed is usually in the form of a range or sequence of machines, set to work in continuous order, finishing up with a drying operation.

Machines for Warp Yarn.

Warps in the ball are mercerised very satisfactorily in a machine of several compartments, resembling the common multiple-box warp-dyeing machine. The first

two compartments serve for impregnating with caustic liquor, and others for the subsequent operations of washing, souring, and washing, in a continuous fashion. Warps in the sheet form, from the beam, are also mercerised on machines of the slasher type.

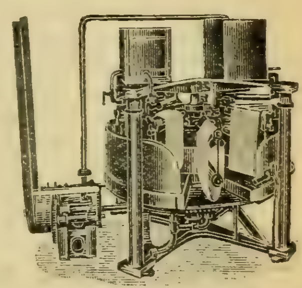
Speed.—15 to 20 yards per min.

Pulleys.—20 in. dia. × 4 in., 120 revs. per min.

Power.—8 I.H.P. **Floor Space.**—60 ft. × 9 ft. 3 in.

Machines for Hank Yarn.

The principle of treating hanks is simply that of manipulating while stretched over rollers, the several systems varying only from each other in the mechanical arrangements for effecting the work with regard to efficiency and economy.



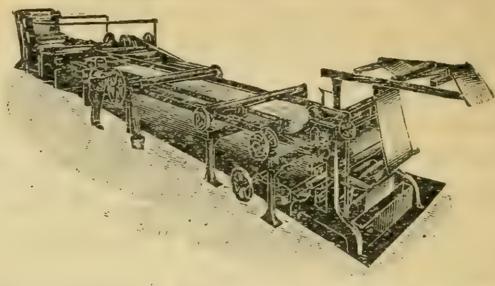
One machine consists of two sets of horizontal arms, of which there are nine at the top and nine at the bottom, all extending radially from a central vertical shaft. At each end of the upper arms is a triangular bracket, carrying a series of small rollers, capable of revolving; and upon each of the bottom ones is a roller of larger diameter, also capable of revolving.

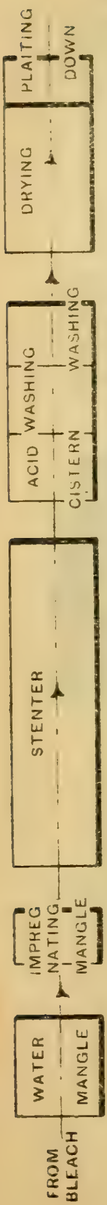
Each hank of yarn to be mercerised is placed on one of the top radial arms, and under the roller of the corresponding bottom arm. It is then automatically put in tension, and is gradually stretched at every ninth part of a revolution of the vertical shaft. This moves intermittently from left to right, and as each arm presents itself opposite the attendant, it is doffed and recharged with fresh hanks. As the recharged arms move to the right, the yarn encounters the caustic liquor in four successive baths, and on the fifth movement it is squeezed and drained of the superfluous liquor. In the sixth the hank is washed in either hot or cold water, and the washing is completed in the seventh and eighth stages. The time of each stage may be regulated to suit circumstances.

Floor Space.—12 ft. 0 in. × 10 ft. 0 in.

Production.—600 lb. in 10 hours.

Machines for Piece-Goods.





SEQUENCE OF MACHINES FOR MERCERISING AND DRYING COTTON PIECE-GOODS.

Many systems are in use for the treatment of piece-goods, but the type most generally employed consists in a range comprising a padding mangle, a stenter, and a series of washing-becks; a set of drying cylinders may also be attached to the range.

In the Padding Mangle the cloth is impregnated with caustic soda. From the mangle it travels continuously along to the Stenter, where, while being gradually stretched to the full width, it is sprayed and washed from above and beneath. As the cloth leaves the stenter it runs directly into the Washing Becks, and is treated subsequently according to the requirements of the finish.

Padding Mangle.—Provided with one or two sets of squeezing rollers, pressure of which is adjustable. Speed: 240 revs. per min. Pulleys: 30 in. dia. × 6 in. wide.

Stentering Machine.—Takes the cloth directly or subsequently from nips of the padding mangle. Length from centre of clip chain-wheels: about 50 feet. Self-feeding clips are provided to stretch out the cloth to its full width. Speed: 216 revs. per minute—25 yards of cloth. Pulleys: 24 inches diameter × 5½ inches. Floor Space: 54 feet 6½ inches × 12 feet.

Drying Machine.—Is usually made with 24 cylinders, arranged in two rows, and of a width to suit the cloth to be dried. Speed: Variable. Pulleys: Variable. Floor Space: 30 feet 6 inches × 10 feet 9 inches. Total length of range: 120 feet.

Another System of treatment consists in batching the pieces after having passed through the

caustic soda and stretched out to width and washed afterwards. These two are the main systems, the first-mentioned being the chief. The treatment imparted depends to some extent upon whether they are to be mercerised before or after bleaching, whether the goods are to be dyed or printed, and the sort of finish desired. It is seldom, however, that the bleaching precedes the mercerising in practice, though attempts have been made to support that course on theoretical grounds.

After having been mercerised, the bleaching is best accomplished by treating in the full width, since the arrangement of the warp threads in relation to the weft is thereby the least disturbed.

Some cloths may, of course, be bleached in the rope form after mercerising, so long as especial care is exercised.

DRYING Mercerised Materials.—The conclusions drawn from experimental evidence—as given by Dr. Knecht before an assembly held in Manchester of members of the Society of Dyers and Colourists—in regard to the influence of drying on mercerised cotton, are that it is undoubtedly affected very materially in its affinity for colouring matters. It was shewn that mercerised cotton dried evinced less affinity for dyestuffs than when dyed without previously drying. On this observation the other conclusions are:—(1) Light places in dyed mercerised goods hitherto ascribed to oxycellulose may frequently be traced to uneven drying, especially of selvedges, which would dye a lighter shade than the rest of the piece. On the other hand, it is seen that dark stains may result from the mercerised material being accidentally impregnated with some hygroscopic substance previous to drying. Such faults are difficult to remedy, the best means being remercerisation of the whole piece. (2) In order to get the full benefit of increased affinity for dyestuffs, the goods should be dyed at once after mercerising, without previous drying. (3) To preserve the full affinity of mercerised goods for printing, impregnation previous to drying with a solution of some hygroscopic substance like glycerine is recommended. (4) It affords a possible explanation why caustic soda mercerises better cold than hot. (5) It should be borne in mind that the factor of temperature in drying has a great influence on any chemical test applied to detect mercerised cotton or to estimate the degree of mercerisation.

DYEING

The dyeing of cotton is carried out at any stage of its manufacture, with a corresponding call for variation in the mechanical means employed. The nature of the colouring matters to be applied also modifies the mechanical side. Of late years the practice of dyeing yarns in forms other than hanks has grown considerably—not only on account of the economy in cost of production, but also through the gradual introduction of a whole range of colouring matters faster than the majority of the direct dyes, and almost as readily applied. Warps, too, are not now only dyed in the rope-form in the stereotyped roller-and-squeezer machine, but frequently at full width through slasher-like machines, and also in the beam state wound on strong perforated tubes; they are likewise sometimes treated in the compact ball in special machines.

Many specially constructed machines are in use for the treatment of loose cotton, slubbings, rovings, cops, cheeses, and beams, modified according to the nature of the colouring matter—direct, basic, mordant, sulphide, or vat dye. Very few changes have come about in the ways of manipulating pieces other than supplementary forms of treatment necessitated in the application of some of the more recent dyes.

The fact should not be overlooked that water used in dyeing and finishing exercises considerable influence on the process, and affects the results.

COLOURING MATTERS, PROCESSES, ETC.

Some of the old colouring matters are still retained for use, notably (among the natural family) logwood, fustic, and indigo; and (of the mineral colours) chrome yellows and oranges, as well as iron buff, and the comparatively modern combination of it with chromium oxide—khaki. Outside of these, the other natural and mineral colours are seldom employed, and have given place almost entirely to their betters.

Beyond the many spheres of usefulness of those classes of dyestuffs known respectively as the direct, basic, acid, mordant, developed, coupled, and azo dyes, the last few years have seen the appearance of many improved forms of the sulphide members, besides the augmentation of this range to the extent of including almost the whole gamut of possible shades. Furthermore, the appearance

of the indanthrenes, the ciba blues, and the thioindigoes, has greatly extended possibilities in the production of bright and extremely fast colours.

The improvements set afoot by the makers of artificial indigo in the methods of applying indigo, in its proper manner of reduction, and the ways of carefully controlling the vats, are all features which have simplified some previous difficulties.

Dyeing Fast Khaki Shades.

With the object of complying with the severe requirements as to the fastness of the colour and the quality of the finished material, three salts (in varying proportions relative to one another) may be used for piece-goods. These are: chrome alum, pyrolignite of iron, and manganous chloride.

The method of working consists in first singeing the cloth either over hot plates or by gas flames. It is then boiled-out by the continuous method or on the jigger; and half-bleached, also on the jigger or continuously. The pieces are then dried over hot cylinders or in warm air. It is necessary for the production of level dyeings that all the pieces for one shade should be equally dried. The subsequent impregnation with the metallic salts is effected on a padding mangle, preferably arranged like the machine employed generally for impregnating piece-goods with caustic soda when mercerising. After impregnation, the pieces are dried on the cylinders, or preferably through the hot flue. The material must not be dried at too high a temperature.

Fixation of the salts in the fibre is then brought about by passing the dried pieces through a boiling solution of caustic soda (12 to 15 deg. Tw.), to which has been added a little sulphoricinate of soda to assist penetration of the liquor. There should always be an excess of alkali present, otherwise the precipitation of the metallic hydrates will take place superficially, and so give rise to serious faults. The pieces are then washed very completely, and soaped. They are next treated at the boil for about one hour in a (12 to 15 deg. Tw.) solution of silicate of soda, which has for its object the rendering of the colours fast to perspiration and organic acids. It is probable that this increased fastness is brought about by the hydrates becoming more or less partially transformed into the corresponding silicates. Finally the goods are washed to remove all loose silicates, dried, and finished.

Foam Dyeing.

This is a process occasionally employed for the dyeing of hanks and cheeses. The material is not actually brought into contact with the dyeing liquor, but is dyed by the coloured foam produced by boiling the liquor. The apparatus is simple, and consists (Hübner) of a wooden box 1 m. square by 1.6 or 1.8 m. high, which is provided with a closed steam-coil, 4 to 5 cm. diameter. The material (about $1\frac{1}{2}$ to 2 cwt.), is placed into a cage made of lattice-work supported by feet, by means of which it is raised about 0.25 m. from the floor of the dye vessel. The dye liquor in the vat must not reach up to the bottom of the cage. In order to produce frothing of the liquor, a small quantity of soap or turkey-red oil is added. No salt should be added when dyeing with the substantive dyestuffs, while the necessary amount of sulphide of soda should be added when the sulphur dyes are used.

Spray Dyeing.

Spray dyeing has secured some adoption for the production of variously coloured effects on fabrics. In some circumstances, however, it exhibits the drawback that the outline of the coloured pattern transferred to the cloth is not clearly defined. Spray colouring is applied to silks, half-silks, and cottons, in sharp lines and designs, but these cannot compare in point of clearness of outline with those produced by roller printing, because in the former instance the colours "run" somewhat. When a mixture of colouring matters is used for attaining the colour required, some undesired and not very becoming effects are produced, because of the varying degrees of solubility of the different colouring matters. Furthermore, the capillary attraction exerted by the different fibres varies.

Weller states (German Patent 37,499/1911) that these disadvantageous features of the process do not come into evidence when the solution of the colouring matter is sprayed on to material in a hot state. There is then no "running" of the colours. For instance, by spraying silk fabrics heated to a temperature of 60 to 70 deg. C. with colour solutions the colours remain and become fixed exactly on the portions of the fabric that have been sprayed. It is claimed that by this means exact designs can be reproduced with very clearly defined outlines. The observation made by Weller seems to be one of particular interest in the printing of fabrics, since, if the

heating of the material immediately prior to spraying is so beneficial in producing clearness of outline, it should be also beneficial in ordinary roller printing.

Ombre Dyeing.—Is a process of dyeing a series of two or more shades of the same, or differing, colour, on material. In the case of piece-goods, the guiding rollers of a dyeing beck may be adjusted at various angles, so as to cause one portion of the cloth during dyeing to come more into contact with the liquor than the other.

THE MACHINE DYEING OF COTTON AND YARNS.

Machines are now constructed for the dyeing of loose material, and of yarns, in all of their stages of manufacture. Many of these machines enable a very high point of productive capacity to be reached, along with a saving of time, chemicals, steam, and labour. The dyeing of loose cotton is a simple operation on the machine. Rovings and slubbings call for great care, however, by their very form. Already spun yarns are dyed in the form of beamed warps, pin-cops, warp-cops, cross-spools, cheeses, and hanks, on machines. The styles of machines employed for these purposes may be placed in two main groups: the Pack System and the Spindle System.

The principle of the **Pack System** depends upon the fact that the material is packed in the compact state, in special holding vessels, so as to form a sort of large block (cops, cross-spools, and hanks), through which the liquor with which the cotton has to be treated is circulated by some force or another. In the case of the **Spindle System,** used especially for cops, cross-spools, and rovings, the material is arranged on perforated spindles through which the liquor is forced, so that each single cop, or cross-spool, receives single treatment with its neighbours in the same machine.

Each of these systems in actual working appears to have both its advantages and disadvantages the one over the other. This is due to the fact that in dyeing by the one or the other fashion, the important factor controlling the results is undoubtedly the particular nature of the material to be treated, and in a similar degree, and equally important, the method of dyeing necessitated for the production of the required colour. With regard to the **spindle system,** the main feature requiring attention is that the material should be evenly wound on the spindle, and not too tightly, so as to admit of even impregnation with the liquors forced through the yarn;

and under these circumstances it offers the advantages over the other system of furnishing level colours, admitting of ready matching and shading to pattern, permitting a thorough washing after dyeing, and of easily removing the excess of water, by suction or centrifugal action, in readiness for the drying operation.

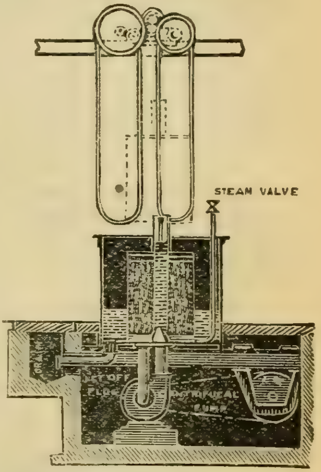
The disadvantages set against the spindle system include the possibility of some of the perforations of the spindles becoming blocked by loose fibres during the circulation of the liquor, thus giving rise to unequal treatment; while, further, it is required that only cops all of the same size may be treated together on perforated spindles each of a standard size in length. Furthermore, the proportion of liquor required to the weight of the material is greater than by the packing system, and in consequence the consumption of dyestuff, steam, and water is greater; and the productive capacity is somewhat lower.

The disadvantages of the one system point to the advantages of the other, and we have therefore, in favour of the **packing system,** maximum production, low consumption of dyestuff, steam, and water, and less labour, along with the fact that the same machine may often be used for more than one form of material. The drawbacks attached to this system are the difficulties of patterning to shade, and of properly effecting the removal of the excess of moisture in preparation for the drying operation; and furthermore a deformation in course of treatment of such forms of material as cops and cross-spools.

Experience has shewn that in general it may be taken that the labour attached to the treatment of **warp cops** is lower than that required for **pin-cops.** As a matter of fact, in some instances it is deemed advantageous to dye the yarn as warp cops and subsequently to wind into the form of pin-cops, for sale. In the dyeing of **cross-spools** less manual labour is required than in the dyeing of cops. In the use of the packing system, the cross-spools should not be wound too tightly, and though in these circumstances the spools more readily lose their shape than when tightly wound, there is more certainty of their being dyed evenly and throughout. After the dyeing, the yarn may be wound into any state that may be preferred. When cross-spools are dyed by the spindle system they may afterwards be sized directly in the same machine, which for many purposes is regarded as an advantage.

For Loose Cotton.

Consists of a cistern provided with a centrifugal pump, the suction and delivery of which are connected to the under side of the cistern. Inside the cistern, and over the delivery of the pump, is fixed a conical seating, upon which rests a perforated cylinder containing the material to be dyed. This cylinder is formed of an inner and outer perforated casing, between which the raw material is placed, the material being held tightly in position by means of a lid forced down by a screw. The cylinder consists of an inner casing with boxes of size suitable for containing the cops, the boxes being fitted with perforated lids, which are easily removable. The apparatus is made with either iron or wood cisterns, and with iron or brass pumps and fittings. The perforated cylinders are usually made of copper; when required for sulphur colours they are made entirely of iron. Dyeing is effected by the continuous circulation of the liquor through the cistern.



For Ball Warps.

For dyeing warps other than those dyed with indigo, the yarn is guided through a bath, and rollers are provided for squeezing out the excess dye liquor.

In indigo dyeing the work is done in a number of vats built together and usually worked in groups of five. On the top of these are fixed rails, along which travels a carriage, enabling the warp to be run through successive vats in order to build up the shade required.

For Yarn in Cross-wound Spools or Cheeses.

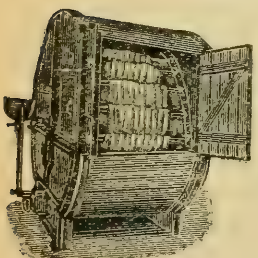
Consists of a cylindrical cast-iron cistern, in one side of which is a rectangular recess extending the whole depth of the tank. The top is closed by a water-tight lid. At the bottom of the tank is a circular iron plate mounted on a spindle, which passes to the outside of the tank, where it is provided with worm gear for causing its rotation. Below this iron plate is a space through which a pipe runs in connection with a centrifugal pump.

The material to be dyed is placed in a perforated iron cylinder, which is lowered into the cistern, where it rests on the revolving circular bottom plate, and comes close up against the walls of the cistern. The lid being then closed and the pump started, the liquor is forced from the outside of the cylinder through the material in it, and down through the space under the bottom plate out of the machine. As the cylinder with the material therein is slowly rotated at the same time, successive portions of the material come in front of the recess whence the dye liquor issues. The liquor can also be made to circulate in the opposite direction.

For Yarn in the Hank.

Dyeing yarn in the hank may be performed either by hand or machine, but where large quantities of yarn have to be treated the latter is most economical and expeditious.

Manual Dyeing.—When the yarn is in small lots, bath tubs are used of such a depth as will take in the full length of the hank, when suspended from a stick and allowed to hang straight down. The sticks are placed horizontally across and are supported by the edges of the tub. The dye liquor in the tub is heated by steam passing through a pipe at the bottom. When large quantities of yarn are treated, rectangular vats or troughs are used in place of the tubs, but in other respects the process of dyeing is the same.



Mechanical Dyeing.—(I.)—In which the machine consists of two discs mounted upon a horizontal shaft, but at a suitable distance apart to form a skeleton cylinder. Arranged between these and extending from one disc to the other, are the sticks from which the hanks, to be dyed are suspended. The bottom portion of the machine is in the form of a trough which contains the dye liquor. As the cylinder revolves the hanks of yarn are passed through the dye liquor. Machines of the above kind will dye as much as 1,000 lb. of cotton yarn in 10 hours.

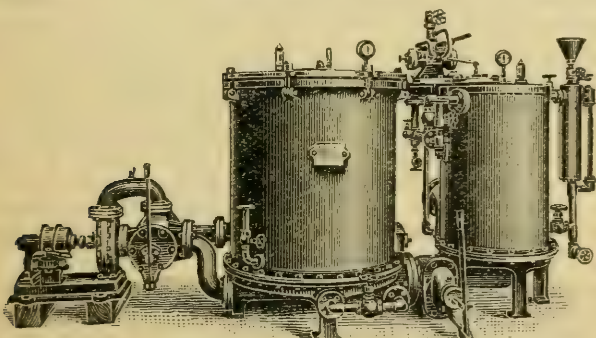
(II.)—In which the yarn is placed on thin flat metal rods, which are automatically hooked and secured to two endless chains, on which they are carried through the vat. After dyeing and squeezing, the chains carry-

ing the yarn are extended to allow sufficient time for oxidisation. Provision is also made for turning the yarn in the rods during dyeing, in order to prevent unevenness in shade.

(III.)—In which a swift or reel containing the hanks of yarn is lifted and rotated in the dye-bath during the dyeing operation. The lifting motion is obtained from two worms on a horizontal driving shaft, which gear into two disc-wheels. These latter are provided with studs, which serve as cranks to raise the iron framework for carrying the reel. As the cranks remove their support, the frame-work and swift fall by their own weight, and allow the yarn to be immersed in the dye liquor. By a simple escape motion (consisting of a ratchet wheel and two pawls) this vertical movement of the frame-work causes the swift to turn about 8 or 9 inches while the yarn is submerged. By this arrangement the yarn is caused to assume 15 different positions in the dye-bath during one revolution of the reel.

For Yarn in Cops and Cheeses.

Systems.—In the pack, or on hollow perforated skewers.



Pack System.—The cops or cross-wound bobbins are placed in holders or drums—an operation involving much time and skill in order to obtain evenness in dyeing. All openings in the drum should be stuffed with fibrous packing, which must be renewed from time to time. Perfect packing on this system is very necessary to obtain good results.

Skewer System.—In this system each single cop or cross-wound bobbin is placed on a perforated spindle, and the spindles are mounted on a cylinder. The system ensures uniform results without depending so much upon manual labour.

All the processes of preparing, dyeing, washing-off, and extracting can be performed in this apparatus, which, in addition to the machine itself, consists of the necessary liquor tanks, valves, and connections. The machine is suitable for direct and basic colours, and is specially applicable for sulphur colours, as neither material nor liquor comes in contact with the atmosphere during the dyeing process. Boy or girl labour is sufficient for the manipulating of the machine and its valves.

The cops are fitted on perforated metal skewers or spindles, which are placed in the holes provided in the perforated cast-iron drum or cylinder. After being filled with cops, the cylinder is enclosed with a perforated casing made of special metal, and by means of a suitable arrangement is lowered on to a seating in the dyeing cistern, the lid of which is afterwards closed and bolted down.

The air is exhausted, by means of an ejector, from the dyeing cistern and receiver alongside it, which are connected by a pipe. The liquor is then allowed to flow from the liquor tank into both the receiver and the dyeing cistern, until they are more than half full. The steam is then turned on, and the liquor is forced out of the receiver into the inside of the drum or cylinder, through the perforated skewers and cops, into the cistern, the drum and material being completely immersed in liquor.

By an automatic arrangement operated by a float in the receiver, the steam connections to the receiver and dyeing cistern are now reversed, and the liquor is forced out of the cistern through the cops back into the receiver. This frequent reversal of the direction of flow of the liquor through the cops takes place during the whole process, thus ensuring even dyeing of the material. For dye liquors which are required to be used cold, a centrifugal pump, with the necessary pipes and valves, is provided, which allows of the frequent reversing of the liquor, as in the case of the arrangement where hot liquors are employed.

These machines are made in various sixes, holding from 5 lb. to 130 lb. of cops at one time, the daily output depending upon the class of colours used, and the variety in the quantity of colours.

By another method the reversal of the circulation of the dye liquor is brought about on lines somewhat similar to those of the well-known slide valve of a steam engine, in which ports or passages close and open alternately, except that in this case the supply goes on con-

tinuously. The mechanism works independently of the pump, and is arranged to conduct the dye liquor through the material from the outside to the inside, and from the inside to the outside, alternately and regularly, without the aid of an attendant. Provision is made for regulating the period of the changes, and every other facility is afforded for ensuring equality in the application of the colour to the material.

For Yarn on the Beam.

By adopting the system of bleaching or dyeing yarn on the beam, a manufacturer can supply his own requirements at comparatively small cost, and with the advantage of having the work under his own control. The bleaching or the dyeing of the beams may be accomplished by manipulation on the slasher machine, modified by the addition of one or more extra troughs. On the other hand, machines specially contrived for bleaching and dyeing of beams are now much in vogue.

The yarn is wound on perforated beams, to admit the passage of the liquor. The beams are carried in special bearings, and are rotated by means of a side shaft and gearing. A system of pipes or conduits is employed; these are connected up to pipes for supplying the dye or bleach liquor, water, steam, or compressed air, a powerful pump being used for the purpose. The liquor is forced through the mass of yarn by means of a pump, and sucked back by the same means, the pump being reversible. This to-and-fro circulation is maintained with one or other liquor until the desired result is effected. In the case of bleaching on perforated beams, these should be made of acid-resisting metal.

DRYING.

To expedite the drying of machine-dyed materials **Extractors** are used. They are arranged to work with two air-pumps, fitted with foot-and-bucket valves. They produce a vacuum of from 25 to 26 inches, and will extract from 60 to 70 per cent. of the superfluous liquor before the cops are placed in the stove to dry.

MACHINES are now made in **chamber form** to take the place of stoves for drying yarn.

(I.) Consists of a number of drying chambers, each provided with its own heating compartment, the heating being effected by steam.

The chambers are arranged to follow one another in alternation with the heating compartments, and heated

air is passed through them, which extracts the moisture from the material and carries it away. The number of chambers may be from three to nine, according to the material to be treated.

The essential feature of this system is that the air is always admitted to the heating compartment next preceding the chamber in which the material has been in the machine longest, and is therefore driest; and it is discharged at the chamber last filled, where it is the wettest. The chambers are filled in succession, and each is provided with an inlet and an outlet valve for controlling the supply and discharge. The material is subjected in the process of drying to as many variations of temperature as there are drying chambers, the course of the air being altered at each successive emptying and recharging of a chamber. The machine is provided with a fan and an exhaust pipe, having branches connected with the respective chambers. The point of suction is regulated by the valves mentioned, at the time of discharging and recharging.

By providing an additional compartment to each chamber, the above apparatus may be used as a Conditioning Machine as well as a dryer. The compartments added communicate with the outer atmosphere and with the chamber containing the material. By means of separate valves, one or more of the heating compartments may be cut off from circulation and the conditioning compartment contiguous thereto opened to the atmosphere. Through this compartment and the chamber containing the material the cold air is drawn for conditioning. When it is desired to apply more moisture to the material than is contained in the atmosphere, water jets are provided which combined form a fine spray to be deposited on the material.

(II.)—In another machine worked on the tray principle, the trays holding the material to be dried are arranged in a square chamber, one above the other. Steam-heated pipes in the bottom of the chamber provide the heat for the air, and a fan is employed for distributing the heated air. The trays are moved mechanically from the top of the chamber downwards. The wettest material enters at the top, and the dried load is withdrawn at the bottom. The mechanism for bringing about the changes is controlled by a series of levers, which are operated at intervals to suit the class of material dried. The machine is self-contained, and occupies a floor space of 17 feet by 7 feet 3 inches. Production: From 2 to 3 tons of dried material per day.

In a modification of this latter, two chambers are employed. In the first of these the drying air and material travel in the same direction, and the preliminary drying is thus effected by the hottest air moving in an even current, after which the air, having absorbed most of the moisture, is allowed to pass away. In the second chamber the final drying takes place, and the material is discharged therefrom by withdrawing the trays as they present themselves opposite an outlet at the bottom of the chamber.

VARIATION OF WEIGHT BY BLEACHING OR DYEING.

It may be generally taken for granted that the loss in weight of a good quality of cotton yarn through the ordinary bleaching operations is about 5 to 6 per cent., though short-stapled fibres containing motes and greasy impurities may lose as much as 8 to 9 per cent. in weight, when the amount of moisture present in both is about the same. The amount of moisture found normally in raw cotton is from 7½ to 8½ per cent., and yarns hold quite as much when not too thoroughly dried, or, on the other hand, when not damped. When light colours are dyed on bleached yarn the loss in weight occurring is due mostly to the bleaching, and as yarn for dark shades is mostly boiled first only with water, the loss in weight undergone is but 1 to 2 per cent. When the yarn is not boiled, but wetted-out simply by adding a soap or turkey-red oil to the dyebath, this loss is avoided; yet when strongly alkaline boiling dyebaths are employed, as in the case of the sulphide dyes, a loss of 4 to 5 per cent. may be observed, according to the duration of the dyeing operation.

It may also be generally accepted that the loss in weight experienced in the dyeing of cops is much the same as in the dyeing of hanks. It is notable, however, that some colouring matters tend appreciably to increase the weight of the cotton: these include indigo, the one-bath and oxidation aniline black, logwood black, cutch brown, the chrome-colours, and turkey-red. Indeed the increase in weight may in some cases reach 7 to 10 per cent. Some interesting experiments on this matter have been carried out. American cotton in 24's warp yarn was treated in portions, one bleached and the other dyed several typical colours, weighings being made before and after treatment only after hanging the yarn for a period of 24 hours in a room at a temperature of 30 deg. C. The

normal weight of a bundle of the yarn was 4.54 kilos. Upon treating, and again weighing after the prolonged drying, the following results were obtained :—

	Weighed. Kilos.	Showed a loss of
Bleached yarn	4.48	1.32 per cent.
Sky-blue indigo yarn	4.52	0.44 ,,
Light-blue indigo yarn	4.52	0.44 ,,
Grey yarn boiled without soda	4.53	0.22 ,,
Medium blue indigo	4.53	0.22 ,,
		Gain.
Dark-blue indigo	4.60	1.32 per cent.
Yellow (cotton yellow)	4.62	1.76 ,,
Alizarine pink	4.63	1.98 ,,
Methylene blue	4.68	3.08 ,,
New Victoria green	4.68	3.08 ,,
Slate (diphenyl black)	4.69	3.30 ,,
Dark-blue (indigo topped with logwood)	4.75	4.62 ,,
Black (one-bath aniline black)	4.80	5.73 ,,
Yellow (chrome yellow)	4.80	5.73 ,,
Alizarine red	5.05	11.23 ,,
Orange (chrome orange)	5.25	15.64 ,,
Dark-brown (catechu)	5.26	15.86 ,,

The small loss accounted for in the case of the bleached yarn may be due to the fact that it was treated by the centrifugal system. That the sky blue, light blue, and medium blue, with indigo, should also show a loss in weight is due doubtless to the relatively greater alkalinity of the vat-liquor. The great amount of manipulation necessitated with these colours in subsequently washing and souring will also account for the removal of many impurities from the yarn.

YARN PRINTING

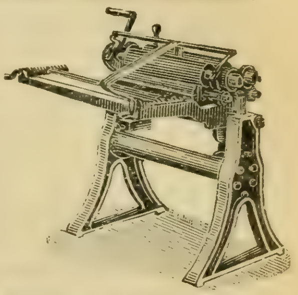
HANK PRINTING MACHINES.

Are made in different sizes, to print from one to six colours.

One-Colour Machine.—The rollers in this machine are usually 19½ inches long on the printing surface by 4½ inches diameter. The yarn to be printed is first opened by a stick and post or shaking-peg, as in ordinary hank dyeing, several hanks being dealt with at a time, according to the fineness of the pattern. A fork is then passed

through the hank to make a way for the insertion of a tension roller.

The hank having been formed into a kind of square, it is now placed in the machine, the fork is withdrawn, and the tension rollers are adjusted. The machine is so constructed that one-half of the printing appliance, with its tension rollers, swings on a gate; and when the gate is closed the printing rollers are together, and are held firm by a latch and lever. As the printing proceeds, the impression roller is turned by hand until the pattern joins, at which point the latch is released and the gate is opened to allow the printed hank to be withdrawn, after which it is suspended on a rail to dry.



By using a special printing roller this machine can be made to print two different colours on the same hank, one inside and the other outside. *Note.*—In cases where the printed parts are broad, they should be felted to form a pad, to keep the colour even over the printing surface.

Multiple-Colour Machines.—In the two-colour machines there are two printing rollers (one pair), four intermediate rollers, and four colour rollers with four colour boxes; one-half of these are on the fixed part of the machine, the other half on the part that swings. In the three-colour machines there are two printing rollers (one pair), six intermediate rollers, and six colour rollers with six colour boxes, one-half on the fixed part of the machine, and the other half on the swing part.

The manner in which the different colours are placed on the printing rollers is as follows:—Between each colour roller and printing roller is placed the intermediate roller, which is to take the colour from the colour roller to the printing roller, and which is cut to miss certain bars on the printing rollers that the other intermediate rollers have furnished with colour.

The two-colour machine will print four different colours, two inside the hank and two outside the hank, making four different colours on the same hank. The three-colour machine will print six different colours, three inside the hank and three outside the hank, making six different colours on the same hank. If the yarn is spread thinly the colour will go through to both sides. **Production**:70 lb. to 200 lb. per day of ten hours.

CALICO PRINTING

In Calico Printing there are four successive groups of operations: namely—

(1) Preparation of the cloth for printing.
(2) Application of the colouring matter to the cloth.
(3) Fixation of the colouring matter on the fibre of the cloth.
(4) Finishing.

(1) Preparation for Printing.

The object is to remove from the cloth physical imperfections, such as down or loose fibres, and loose ends of yarn, that would interfere with the sharpness and clear outline of the printed pattern; and to extract and remove the impurities of the cloth.

These impurities consist of the bodies (other than cellulose) contained in the natural cotton fibre, of the sizing materials added to the warp to assist the weaving, and of foreign matter gathered accidentally during the operations of spinning and weaving. All these impurities, besides giving to the cloth the characteristic dull brownish colour, would, if not removed, prevent the successful fixing on the fibre of the various colouring matters and modify their shades. The removal of the mechanical imperfections is effected by singeing the face of the cloth, by shearing, and by brushing and beating. The impurities are extracted by bleaching.

(2) Application of the Colouring Matter.

This is carried out in a variety of ways. In its simplest form the colours are printed directly upon the cloth; and as most colouring matters have little affinity for the cotton fibre, they are combined with the necessary mordants or coagulants to effect their permanent union with the fibre in the subsequent operation of fixing. Pigment colours are mixed with such bodies as albumen, which, subsequently coagulating under the influence of heat, fasten the colour mechanically.

The mordanted and dyed styles, such as those of the alizarine colours, are not applied directly to the cloth in the printing machine; but certain metallic oxides, as those of alumina and iron, are printed and fixed on the cloth. These metallic oxides have the property of attracting alizarine from its solution; and if cloth on which they have been printed and suitably fixed be worked for the requisite length of time in a heated dyebath of alizarine, the colour is taken up and fixed on

those portions only where the metallic oxides have first been deposited.

In what is known as the "discharge" style of printing, the cloth is first impregnated throughout its whole substance (that is, padded) with some dye material such as aniline salt; then the cloth is dried, but the colour it not developed on it, nor is it fixed. It is next passed through the printing machine, and chemicals having the property of preventing the development of the colour are printed upon it, either alone or in combination with other colouring matters. The ground is then developed by steaming, and the printed pattern, white or coloured, is obtained upon a coloured ground.

(3) Fixation of the Colouring Matter.

This process usually consists in the exposure of the printed pieces in suitable chambers to an atmosphere of steam, which effects the combination of colouring matter and mordant on the fibre of the cloth, or coagulates the albumen which fixes a pigment colour. In some cases, as in that of the mordanted and dyed style, the colour is both applied and fixed in the dye-bath.

Following the fixation or development of the colour by steam, and sometimes as a completion of that process, the goods are in many cases passed through chemical solutions, and immediately thereafter are thoroughly washed, and all good work is well soaped and washed—principally to remove the starch or gum that was mixed with the printing colour to give it the necessary consistency for use in the printing machine.

(4) Finishing.

Finishing is that final treatment of the cloth which is required to give it a pleasing touch and appearance, and make it ready for the market. The goods in their passage through all the foregoing operations have become pulled out of shape—the weft threads are no longer at right angles to the warp—the goods have lost much in weight and have contracted greatly in width, and, owing to their dull and uneven surface, the patterns and colours printed on them are not seen to the best advantage. The crooked threads must therefore be straightened; lost weight must be restored by starching, or, where weight is not required, some softening material may be added to give an agreeable touch to the cloth; lost width be restored by stretching; and finally a smooth and more or less lustrous face must be given to the

goods by calendering. After these processes they are ready for folding and packing.

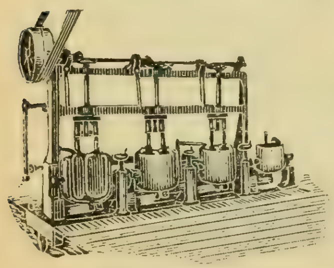
MACHINES, &c.

Preparation of the Cloth for Printing.—Particulars of the machines, etc., employed in this series of operations will be found in another part of this Section, under the head of "Bleaching."

Application of the Colour:—

Colour Shop.—Here the colours to be used are prepared, mixed to the strength required, and thickened with gum or starch, to give them the pasty consistency necessary for printing on engraved copper rollers without flushing.

The plant comprises a considerable number of open copper pans, of capacities from 5 to 150 or 200 gallons. They are double cased, the outer cavity being heated by steam or cooled by water at will. The pans are arranged to swivel for convenience of emptying. In each pan is a pair of revolving brass stirrers, driven by overhead gearing. In these pans the colours are prepared and mixed with thickenings; they are then strained to free them from lumps or grit before use. There will also be a strongly-built closed pan with internal agitators, for dissolving gums, which require high pressure steam to liquefy them.



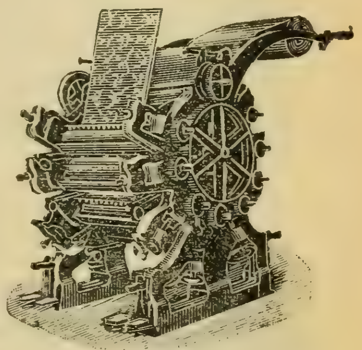
Engraving.—The methods of applying the patterns to the copper rollers used in the printing machine depend largely upon the class of design and work produced.

Hand engraving is by far the most expensive and the slowest, and is now only employed for very fine shaded work, or as an accessory to one of the mechanical processes. For bold designs the pentagraph method is employed; this is an etching process. The copper roller is coated with varnish, the design is then cut in this varnish on the pentagraph machine by a number of diamond points, which simultaneously copy the movement of a pointer guided by the operator over an enlargement of the design to be engraved. The roller is then etched (where the varnish has been removed) in a nitric acid bath to a sufficient depth to carry the printing colour.

Fine designs are engraved by milling, which consists in running in contact with the copper roller a narrow hardened steel roller on which a *facsimile* of a section of the design has previously been raised in relief; great pressure is applied to the mill, and this impresses the pattern in the copper to the required depth, and the process is repeated until the full width of the copper roller has been covered.

Another process is that of photo-etching the copper roller. This has been improved considerably during recent years; and for complicated designs, especially those requiring much shading, which would otherwise have to be engraved at great cost by hand, it has advantages.

PRINTING MACHINES.—The printing room should if possible have a northern aspect, with broad high windows or glass verandah. The machines may vary in size from the simple machine printing one colour only, on one side of the cloth, to a machine printing as many as 16 or 20 colours. There are also duplex machines printing both sides of the cloth at one operation, and intermittent machines producing "saries" or scarves for Eastern buyers.



In all these machines the principle employed is the same. The cloth to be printed is led round a strong cast-iron cylinder, which has been given an elastic surface by winding on it many turns of a mixed wool and linen fabric. Against the cloth, so supported, the engraved copper printing rollers carried on strong steel mandrils are pressed by levers or by screws and springs. The colour contained in the engraving is taken up by the cloth as the elastic bed which supports it presses the cloth into the engraving.

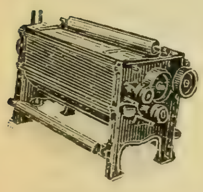
In the case of a multi-colour machine, each roller has engraved upon it a part of the design, and is supplied with the proper colour for that part; the rollers are arranged in radial slides round the central bowl, and are so geared together and adjusted, relatively to one another, that the separate portions printed on the cloth fit accurately together, and make up the complete design.

Intermittent Printing Machine.—

Function.—For printing scarves, handkerchiefs, etc., in which cross borders have to appear.

Description.—Consists in the employment of a special printing cylinder, into which a ram is fitted. At the inner end of this cylinder suitable passages and connections are formed, to allow the flow of water, under pressure, into or out of the cylinder. From one end of the intermittent printing roller motion is transmitted by means of chain-gearing and change-wheels in a quadrant arm. A wheel on this latter operates a cam, which in turn operates the piston of a specially constructed valve, which it opens and closes periodically at such times as is determined by the printing. This action forces the ram outward, and in pressing against the shaft of the printing roller pushes it out of contact with the fabric, and holds it apart until the next print is required to be taken. The printing roller is then brought back into contact with the fabric by means of springs, which are held in compression while the roller is out, and which act when the water is released from the cylinder by the valves mentioned.

By the introduction of worm-and-wheel gearing, a steady drive can be imparted to electrically-driven printing machines that receive their motion power direct from individual motors.



Blanket-Washing Machine.—For cleaning and removing the colour deposit from printing machine blankets. Usually consists of a sheet-iron casing, in which works a wrought-iron bowl 12 inches in diameter. Two brushes are employed for washing the selvedges of the blankets, and another (the full width of the machine) for the body of the blanket. The brushes are caused to traverse sideways by means of a cam arrangement. This machine is usually driven in conjunction with the printing machine.

DEFECTS OF MACHINES.—The production of coloured patterns in many colours and with a large number of rollers becomes more and more extensive; but in point of nicety of impressions and exactitude in reproducing the pattern and in the cost of the work, all of the present roller machines offer serious disadvantages. The

printing paste deposited by the first rollers on cloth they come into contact with becomes spread somewhat under the pressure exerted by the succeeding rollers, and also soils the non-engraved portions of these rollers. This occurrence causes not only the soiling of the colours and a weakening of their intensity, but as the work goes on gives rise to serious irregularities in printing. The elimination of these inconveniences, the seriousness of which is greatly increased in the case of the steam-colours, would bring about a great and fruitful improvement.

To attain this object, it has been thought that surface-machines might be used in which either all the rollers or a certain number of them should be engraved in relief. Ordinarily these rollers have been made from wood with metal blocks attached. But a disarrangement easily occurs, and the method is really only of service in the printing of very large patterns. A solution of the question therefore can only be sought in an attempt to combine a roller-machine in such a way that it shall be exempt from the drawbacks mentioned, and give impressions as perfect as can be obtained ordinarily with engraved rollers.

"Doctors": Corrosion and Wear.—A desideratum in calico-printing is a metallic alloy or other proper substance to serve for the "doctors" of rollers, combining the elasticity and durability of steel with the property of not giving rise to any chemical action in the presence of pastes that are acid or charged with certain metallic salts. Pastes charged with salts of copper or of iron, to the maximum, energetically attack steel doctors and promptly put them out of service; at the same time the paste becomes charged with iron, which is often a serious inconvenience. At other times the attack is much less active; for example, when the paste contains acetic acid or other substance endowed with weak acid properties. The function of the doctor may then be not appreciably hindered; but the use of certain pastes which are incompatible with the slightest trace of iron makes the work almost impossible. This is especially so with alizarine reds. Doctors made of composition have been tried as substitutes for steel doctors in these different cases, and have proved sufficiently resistant to such solvent actions. They are, however, too soft, and lack elasticity; also they wear quickly by the friction be-

tween the engraved roller and the solid particles in suspension in the printing paste—the results being far more serious than those arising from steel doctors.

Doctors are required that possess the resistance of steel doctors to mechanical work and the resistance of composition doctors to chemical actions. It would perhaps be well to study the influence that different substances might exert on the properties of steel when combined therewith in small quantities—tungsten, for example. Trials have already been made with platinum alloyed to a small quantity of iridium; perhaps by varying the proportions a better result might be attained. Berzelius has stated that a small quantity of prosphorus combined with copper can be made so durable as to be sharpened and made into edged instruments. It may be noted here that the Industrial Society of Mulhouse has this year offered a medal of honour for the production of a suitable doctor of metallic alloy or other substance.

Brushes and Blankets.—The Mulhouse Industrial Society also offer a silver medal for a furnisher brush that shall advantageously replace those of horse-hair or pig bristles actually employed; likewise a medal of honour for a system permitting the suppression of "blankets" in printing, with a notable economy.

The defect of the brushes commonly in use consists in the fact that the hairs come off into the paste during work, and lodge under the doctor, thereby causing printing defects known as "doctor faults." The new brush should not scratch the roller, nor be attacked by contact with acid or alkaline printing pastes; should penetrate the engraving to clean it, and be itself easily cleaned with warm water. The recent employment of washing brushes of rubber raises the hope that a solution of the question may be found in this direction.

The inconveniences of blanketing systems that depend on the use of rubber-covered cloth (which has to be washed, then dried either by hot air or on steam cylinders) arise out of the impossibility of eliminating the water interposed in the interstices of the fabric. Under the pressure of the rollers, the interposed water is pressed on to the cloth undergoing printing, and causes the colours to "run." It is required therefore to find a coating of rubber which is not liable to form fissures, or a coating of another nature not exhibiting this defect.

DRYING AFTER PRINTING.

The cloth after having been printed requires to be dried at once. The most convenient arrangement is generally to have the drying chambers in the storey above the printing room. This keeps the print-room cool, and leaves the space behind the machines free for the manipulation of the cloth and back greys, and for washing-boxes for "doctors," also for forcing machines to press the copper rollers on the mandrils.

Various types of drying apparatus are employed. The simplest are those in which steam-heated plates and steam-heated cylinders are combined. This arrangement is compact and economical, but is hardly so suitable for the finest and most delicate colours as what is known as the "hot air" type of drying chamber. By the latter method the printed cloth is led directly from the printing machine, passing over a number of steel steam-heated chests, but just out of contact with their surface, and guided by rollers on oblique framing of the apparatus, to the drying chamber proper. This contains a large number of tinned iron rollers, round which the cloth passes over a large central roller which is driven from the printing-machine bowl.

In spite of certain resistance manifested in calico-printing circles, and particularly in France, hot-air chambers are gradually displacing the old hot-plate system of drying. From the first point of view the last-named system appears to be the more economical as regards cost of heating; in effect the less intense circulation of air decreases the expenditure of heat. On the other side, however, certain delicate colours, such as light alizarine pinks, may suffer in beauty through contact with hot-plates and yet the abundance of condensed water formed in the chamber may cause soiling of the fabrics. Besides, by a rational utilisation, it is possible to lower the cost of drying in the hot-air chamber. The ventilator causing the circulation of the hot air can be supplied with a special electric motor, the speed of which can be regulated according to the varying quantity of air needed to effect the drying of different qualities of cloths. The most economical mode of heating the air consists in employing central heating, using as much as possible of the waste and escape steam formed in the works. To control easily the distribution of the hot air in the dryers, a series of signals may be used in the form of red discs, as on railway systems, thus providing a

ready means of seeing at any moment whether the quantity of hot air being supplied corresponds to the volume required at the time.

FIXING, SOAPING, DYEING, AND FINISHING.

Fixation of the Colouring Matter.

The printed cloth having been dried, it is generally necessary to fix the colours so that they cannot be removed by washing; and in the case of some styles, such as aniline black, it is only after passing through a subsequent developing process that the black itself is produced, and is fixed on the cloth by the oxidation of the aniline in an atmosphere of steam.

The goods after printing and drying are plaited-down, sorted, and then moved forward to an ageing and steaming room, containing several short steam-boxes known as "agers," and a large brick-built continuous steamer for giving a prolonged exposure, of such styles as require it, to the process of steaming.

Soaping and Dyeing.

After the ageing or steaming, the goods go forward to the dye-house, where they are sorted into lots according to styles. If the goods are printed in what are known as the "steam" or "extract" mode (in which both mordant and colouring matter are printed together on the cloth and developed and fixed by steaming), they enter directly a long open soaping and washing machine. The principal function of this is to remove, by a thorough washing, soaping, and squeezing, those thickening materials that were added to the printing colour to give it the necessary consistency.

After leaving the open soaping machine, the goods are frequently run continuously through a heavy three-bowl water mangle, which squeezes them as thoroughly as possible, leaving little water to be evaporated from them on the cylinder drying machine, over which they next pass before being plaited down. To save space in so long a range, the drying machine generally has vertical framing, and may have from 20 to 30 cylinders.

In addition to its primary function of soaping and washing, the range in question is put to many other uses. For instance, the first cistern may contain a solution of tartar emetic for fixing basic colours in combination with tannin, after which follow the soaping, washing, and squeezing. Other uses are to develop naphthol colours and to chrome aniline blacks.

Again, the operation of chloring is frequently combined with that of soaping and drying. To provide for this, there is placed immediately behind the soaping machine a padding machine, in the trough of which is a very weak solution of bleaching powder. The cloth, after soaping and washing, is run through this, and the effect is to bleach out any slight streaks or traces of colour which may have been accidentally smeared on the face of the goods; but it is not so strong as to attack the regularly printed pattern. The cloth is now ready to go forward to the last group of operations necessary to make it ready for the market.

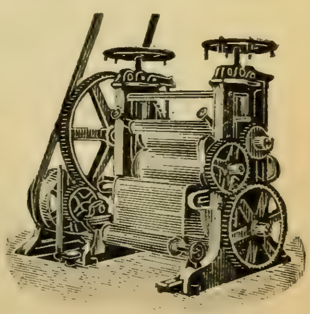
Finishing.

After leaving the dye-house, and being dried, the goods are delivered into a sorting room for examination, and for making into lots according to the particular finishing processes that they are to undergo.

Although the colours they carry are now bright and fast, they are not seen to the best advantage. They have been affected detrimentally in passing through the long series of operations that followed the printing process, and the cloth has become pulled out of shape, especially when it has been treated in the rope state in the dye-house. Further, the cloth is full of creases, and has a dull and uneven appearance that does not show off the colours to the best advantage; also it has lost so much of its weight and substance in the bleaching process that it is now soft and limp and poor to the touch.

The operations comprised under the general term "finishing" are designed to remedy these defects, and to turn out the goods in the best possible condition both as regards appearance and touch.

The width is increased and equalised; and the weft threads, and with them the pattern, are straightened by stretching and drying the cloth on the stentering machine. By combining this with a starching mangle, the necessary weighting (or, if required, softening material) can be given to the cloth before drying it on the stenter with hot air.



If for certain goods it is not necessary to employ such an expensive process as stentering, the cloth may be starched and then dried over steam-heated cylinders,

and subsequently stretched on clip or belt stretching machines to the required width. This process, however, does not give such a good effect as that in which the drying is performed by hot air, while the goods are in a constantly stretched condition.

The final smoothing or ironing of the calico is accomplished by passing it, in a suitably damped condition, between the polished bowls of various kinds of calenders. The bowls are of metal, heated or cold, and of an elastic but comparatively hard material, such as compressed cotton or paper. Considerable pressure is put upon the bowls by levers and weights, and the result is to give the desired smoothness and lustre to the fabric.

BLOCK PRINTING.

The difference between block printing and cylinder printing resides in the fact that while the block not only deposits the colour upon the cloth but to a greater or less extent forces it in, the cloth in cylinder printing has to absorb the colour (mainly by capillary attraction), since the clothing on the bowl does not generally suffice to press the cloth completely into the engraving of the roller. The same colours will not answer indifferently for block and cylinder. Block colours can usually be worked much thinner than machine colours, and it is possible to apply colours by block that it is very difficult to work in a machine, such as those which contain insoluble matters like china clay, sulphate of lead, etc.

For dark shades upon woollen cloth the block has an undoubted advantage over the cylinder, because not only does wool demand much more colouring matter than cotton to produce a similar shade, but it does not draw it up so quickly; its fibres are not wetted so soon as those of cotton, and consequently it does not take up the colour from the engraving in sufficient quantity.

PRINTING BY "LITHOGRAPHIC" OR TRANSFER PROCESS.

The adaptation to cotton fabric printing of the ordinary "lithographic" colour-printing process has lately been accomplished by Mr. Jefferson Hayes, and perfected by a company which has established works in Ramsbottom, Lancashire. It dispenses with many of the operations associated with the use of ordinary coal-tar and vegetable colours, and avoids the enormous expenditure incurred in providing and stocking copper rollers, and in engraving the patterns thereon.

The principle involved is that of printing upon the fabric with "lithographic" or oil colours, and thereby dispensing with the customary practice of "fixing" the colours after printing, which latter operation is essential when aniline or allied colours are used.

The actual process of printing is continuous, as in ordinary calico-printing; but instead of engraved copper rollers being employed for printing the patterns, the effect is obtained by the use of metal rollers upon which the designs are "transferred" directly from plates upon which the designs have been originally drawn. An ordinary design can be put on the plate and transferred to the roller, and the machine be made ready for running off the pattern, in a few hours. As soon as an order is completed from any given design, the rollers may be cleaned and fresh patterns be transferred thereon. All that is necessary in order to ensure a correct repetition of any particular design in case of a repeat order, is to keep in stock the metal plate upon which the pattern was originally drawn, and from which the transfer was made to the printing rōller. There is practically no limit to the circumference of the pattern rollers. In one machine these rollers will print a 108-inch repeat pattern on cloth 56 inches wide, and on this same machine any other size of roller may be used down to 9 inches of circumference.

On leaving the printing machine the cloth may be put through a starching and finishing range, or through an ordinary washing and soaping range, to take off the superfluous colour; or it may be taken directly to the drying chamber.

ROTARY STENCILLING MACHINE.

Function.—Distributes coloured designs upon silk scarves and other fine fabrics by means of spraying apparatus and stencil plates.

Description.—The machine is provided with a skeleton cylinder, around which is mounted a stencil plate containing the patterns. The sprayers are arranged inside the cylinder, and receive the colours from jars or vessels placed in close proximity to the machine, the colours being conveyed to the machine through flexible tubing. The material is fed to the machine from the roll, and is drawn round the stencil plate by an endless sheet, which also serves as a backing, in the same capacity as a printer's blanket. When very soft blending of the colours is necessary, a second set of sprayers, in front of the cylinder, are brought into action, and are

operated in exactly the same way. The amount of colour discharged by the sprayers is regulated by a thumb-screw, and each spray is regulated independently of its neighbour. A screw enables the operator to increase or decrease the amount of all sprays simultaneously. The opening and closing of the sprayers is controlled by electricity, a separate magnet being fitted to each; and the current is started or cut off mechanically according to the design wanted.

The material having received its due proportion of colouring matter, is guided over a steam-heated drying cylinder, whence it is rolled up or plaited down in the usual manner. It is then ready to undergo the process of steaming; or it may be taken directly to a calendering machine, if such treatment be necessary in the finishing. By this method of printing exceedingly fine gradations of tints and blendings can be put upon fabrics, and the most charming effects produced.

FUEL IN PRINTWORKS.

An extensive study of the cost of fuel in printworks has been submitted by Boeringer to the Société Industrielle de Mulhouse. In the cost of printing fabrics the charges for the fuel represent a sum perhaps less important than the general expenses: they are high enough to make a reduction very desirable. The cost of the fuel varies in different establishments. It depends upon the class of work carried on and the methods of working, the weight of cloth handled, the more or less economical way of generating and of utilising the steam, and many other features, all of which make it impossible to indicate even approximately the weight of steam necessary in the production of a printed piece of cloth. As each establishment has particular conditions peculiar to it, the economies to be realised necessitate different solutions, and the conditions in each case must be properly studied. The matter may, however, be considered in a general way. The question rarely presents itself in a simple form, and generally in studying economy of fuel it is necessary to take count not only of the first cost, but also of its possible influence on the other factors of the cost of production.

For example, centrifuging generally leaves less water in the pieces than does squeezing between rollers, but as the latter system permits of more easily working continuously the true economy rests with it. Even a superficial examination of the question shews the main con-

siderations : (1) Economical production of the steam, (2) economical conveyance of the steam from the boilers to the different consuming points, (3) the best utilisation of the steam and the various machines, and (4) rational utilisation of lost heat. All economies find their place in one or the other of these categories. There is, however, no doubt that the most important factor is the economical production of the steam.

The maximum yield from a boiler is about 80 per cent.; there are always losses : smoke about 10 per cent., incomplete combustion about 5 per cent., and radiation 5 per cent. Often enough there is only a yield of about 60 per cent. The author then proceeds to discuss at great length such points as the selection of the fuel, the style of boiler, and the manner of stoking and of securing good combustion, and the economisers. Support is given to the value of automatic firing.

FINISHING

The several processes of finishing have for their object the improvement of the appearance of the cloth—and as often as not its strength—as well as (in other instances) the augmentation of its weight and the modification of its feel to the touch. The imparting of these special characteristics is carried to the extent of giving to certain makes of cotton goods the appearance and semblance of linen, wool, or silk. Finishing is an extensive and complicated art : for, at the outset, the various manners of working secure initial modification according to whether white, grey, coloured, or printed goods are under consideration. Many forms of treatment call for the provision of specially constructed machines; and such considerable progress has been made in this direction in recent years, that not only by their use may cotton goods be given the chief characteristics of silk goods, but even the appearance of embossed paper.

The several main operations that are variously called into use may be classified in the following manner, though order of procedure is necessarily dependent on circumstances :—

Singeing;	Impregnating;	Stentering and Stretching;
Raising;	Breaking-down;	
Shearing;	Damping;	Doubling, Measuring, and Plaiting;
Brushing;	Mangling;	
Steaming;	Moireing;	Marking, Pressing, and Packing.
Starching;	Embossing;	
Calendering, various forms;		

Many of the single operations are likewise modified according to the quality of the cloth and the nature of the finish desired. For instance, that of calendering takes many forms—from the comparatively simple process of exerting pressure on the cloth for giving a slightly smooth surface, to more complicated ones, and to "**schreinering**" for a very high gloss. (See description of Schreiner calender, p. 465.)

The vagaries of fashion are every season calling for more or less new finishes on special sorts of cloths; but leading main sorts are produced from season to season for certain markets, and some of the more general of these may be briefly passed in review.

In self-coloured and white goods may be mentioned the following qualities:—Calicoes, stripes, quiltings, piqués, moleskins, satins, ticks, twills, muslins, crêpes, orleans, mulls, nainsooks, medium and light medium printed calicoes, dhooties, shirtings, and cretonnes.

These may be divided into two classes:—(1) One including those that remain grey or white, or are to be printed (but all to receive some degree of gloss); and (2) Twilled and figured goods.

Cretonnes are usually given a good coating of starch, and following this come drying, sprinkling, calendering, and doubling and pressing. They are for the most part printed goods. Many very light cottons are, after bleaching, only very slightly starched and lightly calendered. Potato and wheaten starch, along with a little china clay, are used for the purpose. Should a gloss be required on such goods, a very weak starching is given, followed by hot calendering.

Shirtings, on the other hand, require a different form of treatment, because these and many other sorts call for both the appearance and the feel of linen goods. This demand forces the use, besides starch, of wax, tallow, china clay, and soap.

The good qualities are finished on both sides, then dried, damped with hot water containing magnesium and sodium sulphates, allowed to lie for a time in the rolled state, and then mangled or beetled.

The thicker qualities of cloths come in for all forms of treatment, according to the finish desired; for a fairly hard satin finish the material may be impregnated with a starch paste containing potato starch and tallow; then

dried, damped, calendered, stentered, and beetled. On the other hand, for a soft satin finish a good course of damping, followed by calendering under high pressure but without friction, suffices.

The "scroop" of silk is imparted to a fairly satisfactory extent by adding to the starch paste common salt or tartaric acid, borax, or alum; though to attain by suitable calendering the high lustre, Glauber's salts come mostly into use. Fustians and moleskins, after raising and brushing, are finished with gum and dextrine.

These instances clearly shew the nature of the varied manners of working called for in finishing, and themselves point to the fact that each operation, when essayed, effects its own special modification of the cloth. Moreover, consideration requires to be given to the behaviour of the finishing compounds that have been applied to the material, under the subsequent influence of such mechanical operations as raising, mangling, calendering, and so on. It is, of course, known that not all the different sorts of starches give the same results after mangling; whereas one will impart a somewhat soft handle to the cloth after mangling or a sharp calendering, another gives a hard touch. One variety of starch will give a cooler touch to the cloth after hot calendering than another sort. Perhaps the coolest feel is imparted by rice starch, then come wheat and maize starch, and last, potato starch. Potato starch gives the thickest pastes, yet the softest touch to the cloth, while the opposite properties are usually imparted by maize starch.

In circumstances where the cost of production must be lowered, mixtures are employed of potato starch and wheat starch, or potato and maize starch. For the better classes of linen imitations, where the cost of production need not be lowered at the expense of the result, rice starch is the best, though wheat starch may take its place when the former is too dear for the purpose. Varying properties are also shewn by other products used in finishing pastes.

Fatty bodies are employed for imparting softness to the cloth, and each gives a result that varies in some respect from that given by the other. The liquid fats give a warm tone to the cloth after mangling or calendering—whereas the solid fats, especially those with the higher melting points, give a cold tone to the cloth. The same

differences come into evidence when it is intended that the cloth shall have a high lustre, for the production of which only those fatty bodies with high melting points should be added to the finishing pastes. On the other hand, liquid **Oils** are only usually required for special purposes, such as when china clay fillings are used, and in these cases the heavier fats give more gloss to the fabric than do the liquid oils.

A certain proportion of **weighting** bodies has often to be added to the finishing paste; but it is not advisable to use so frequently as some recommend such substances as sulphate of soda, magnesium sulphate, and magnenesium chloride. The best and safest agent for the purpose is china clay, and next the sulphates of lime and of barium. The exceptions which may arise are the instances when black or dark-coloured goods are to be finished. The three salts first named are very soluble, and are consequently liable to crystallise on the material during the drying operation. When goods filled with these salts are mangled or sharply calendered, the consequent friction and pressure cause the crystalline bodies to damage the material—often to a most pronounced and disastrous extent. Such damage to the material may not be expected to occur with the use of china clay fillings.

For the finishing of cotton fabrics dyed in **dark colours**, a starch paste made according to ordinary procedure would result in flattening or "saddening" the colour, and also in imparting to the cloth an unpleasant greyish appearnce after mangling or calendering. But when the paste has been boiled sufficiently long before application, or when this process is accelerated by the addition of proportionately small quantities of the stronger acids, or alkalis, or a diastase product, the paste may be obtained quite clear and the starches converted for the most part to the soluble state, dextrine and sugar.

Prolongation of the boiling operation causes the formation of more and more dextrine and sugar. This progressive process of liquefaction causes the paste to lose in the feature of "body": therefore, for the attainment of certain effects, proportionately more starch must be employed than in a paste prepared ordinarily. It is the custom in the case of finishing many classes of dark-coloured goods, to avoid this extra expense, by employ-

ing instead the ordinary finishing pastes, and counteracting their likely effect on the colour by adding suitable colouring matters to the pastes. In many circumstances it suffices for this purpose to add to the paste some of the same colouring matter that had been used for the dyeing of the cloth, but this plan often detracts from the ultimate appearance of the cloth. The lighter classes of woven goods which require the interstices of the fabric to be filled up with the finishing paste, shew, when filled by such a coloured paste, a great difference when viewed by transmitted and by reflected light, even when the same dyestuff has been employed as for the dyeing of the cotton. This observation applies particularly to the substantive dyestuffs.

When, however, such full-bodied colouring matters as logwood, catechu, and fustic, which yield precipitates with metallic salts, are employed, the fabric so finished is likely to present a more perfect appearance when viewed either way. These natural colouring matters in recent times have been neglected by the younger generation of finishers, but their suitability in the present respect and for many other purposes should not be overlooked.

China clay is a very serviceable filling agent, but when it has to be applied to black or dark-coloured goods, the streaking of them has to be avoided by the addition of such a quantity of colouring matter to the paste as shall disguise the white colour of the china clay—with the result, in many cases, that the cost becomes too great. The effect sought may be reached in a cheaper way by the use of more starch.

‘ Permanent ’ Finishes.

Besides mercerising and schreinering as means for imparting a lustre to cotton fabrics—processes that have had a good run for many years—methods for rendering the lustre more lasting have come into vogue, and are being received with great favour. About the first improvement made on the Schreiner patents was one (Williams and Co.) by which the lustre was increased by the utilisation of friction in combination with the use of rollers engraved with lines of diagonal and of horizontal direction.

Other improvements consist in (*a*) means of coating; (*b*) means of coagulating stiffening materials; and (*c*) the use of fats. None of these methods has come to be

of any great importance, a greater measure of success having been reached by the employment of mechanical means. Some five years ago a patent (Bemberg) was worked, which claimed that "a good and permanent lustre is produced on cotton fabrics by first giving a high finish by calendering under great pressure, and at a high temperature, and then fixing the lustre at the expense of a slight diminution of its intensity. This is done by immersing the goods in cold water or sprinkling them with it, or by washing them with soap."

This was later modified in various details, and a more successful solution of the problem seems to be found in the Palmer patent, September, 1909. Here the pieces are likewise fed in quite wet condition into the calender; but the pressure and the feeding speed are regulated in such a way that, in spite of using temperatures so high that dry pieces would immediately burn, they emerge from the calender still wet and therefore also undamaged. The influence of the heat is here limited to the surface only of the cloth, and as the interior still contains water, which must boil up on emerging from the roller, it is ensured that nothing but real permanent lustre is produced. The rate of production is very large. The "Radium" finish is remarkable for its high and peculiarly bright lustre, of great permanence, which is said to be produced by means of this process in several operations.

The Waterproofing of Cotton Fabrics.

The various methods of imparting water-repellent properties to cotton fabrics may be conveniently classed under two main heads—(*a*) the one covering the processes of applying a layer or coating of substances such as india-rubber, gutta-percha, and varnish; and (*b*) the other the impregnation of the material with fats, paraffin wax, and solutions of salts of metallic oxides. The processes under the first heading naturally alter very materially both the character and the appearance of the cloth, whereas some of those of the second class may be controlled so as to alter these features very little if at all.

The chemical treatment is therefore the more popular, especially in the case of cloths intended for wearing apparel. About the best—and certainly the most used—process depends upon the application of a solution of soap and solutions of various metallic oxides. In this way an insoluble metal-soap is precipitated on the fibre, and the cloth becomes relatively water-repellent, while

retaining its original appearance. The coating of the fabric with rubber is accomplished by dissolving the rubber in turpentine or benzol, which is applied by means of brushes operated on specially contrived machines. Paraffin wax is applied in the pulverised state by spreading over the cloth, which is then caused to pass over a heated iron plate. Under some circumstances the cloth is passed through molten wax contained in a suitable trough, or a solution of the wax in naphtha or benzene.

Of the impregnation methods, depending to some extent upon chemical reaction, that relying upon the use of acetate of alumina is much employed. It results in the precipitation of the insoluble basic acetate on the fibre. A 1.7 per cent. solution of acetate of alumina answers the purpose as long as the cloth is well impregnated therewith; the subsequent drying should take place at a heat not higher than 38 deg. C.

Another process consists in employing two liquors—one composed of a solution of soap and silicate of soda, and the second a solution of acetate of alumina. Zinc sulphate has also been used for the purpose, the cloth being passed through its solution (6 lb. to 10 galls. water), and then through a finishing paste composed of dextrine, palm-oil soap, and potash. Nitro-cellulose, as a coating or film, has been suggested, but its inflammability does not recommend it. Acetyl-cellulose gives more satisfactory results, and has formed for a season or so the basis for the production of a popular class of coated rainproofs.

Flame-Proofing or so-called Fireproofing of Cotton Fabrics.

There has for a long time been a demand for cotton fabrics of the nature of muslins and flannelettes to be so treated that they shall shew some resistance to the influence of fire. To meet the requirement various products and many processes have been used. Among these are the silicates of soda and of potash, borax, acetate of alumina, alum, certain salts of ammonia (notably the phosphate and the chloride), and the tungstates.

As long as the fabric is not washed after the treatment, most of these compounds are serviceable to a certain degree; yet, while conferring the immunity desired, they impart at the same time other characteristics. Alum may cause the tendering of the material by heat, even by that involved in the course of drying; and the silicates give a very harsh "handle" to the cloth.

Others attract moisture, thereby causing the cloth to become damp after exposure. These may, however, serve for many purposes; but when the fabric is required to pass through many washings satisfactorily (as is the case with flannelettes in the form of garments), the course of treatment requires to be greatly modified.

In these circumstances the material affording the protection against flame requires to be precipitated in an insoluble state on the cloth. This condition is best met by the use of the tungstates and suitable precipitating agents, each applied successively. Apart from the tungstates, certain oxides of tin have been proved to be very satisfactory. As a matter of fact, a largely-advertised flannelette has been for years treated according to the following method :—

The material is run through a solution of stannate of soda of approximately 45 deg. Tw., in such a manner that it becomes thoroughly impregnated. It is then squeezed to remove the excess of the solution, and passed over heated copper drums in order to be thoroughly dried. After drying it is run through a solution of ammonium sulphate of about 15 deg. Tw., and again squeezed and dried. Apart from the precipitated stannic oxide, the material now contains sodium sulphate, and this is removed by a passage through water; the material is then dried, and subjected to the ordinary processes of finishing. This treatment withstands washing, and to a reasonable degree resists flame.

Other combinations, having, of coarse, differing effects in lasting properties, are the following :—

(*a*) 180 parts soap powder, 24 silicate of soda, 8 lanoline, 7 glycerine, and 4 tungstate of soda.

(*b*) 50 parts alum and 50 phosphate of ammonia—to 1,000 water.

(*c*) 60 parts alum, 60 borax, 10 tungstate of soda, and 50 dextrine—to 1,000 water.

(*d*) 80 parts sulphate of ammonia, 20 borax, 30 boracic acid, 10 glue, and 20 starch—to 1,000 water.

(*e*) 25 parts sulphate of ammonia, 30 carbonate of ammonia, 30 boracic acid, 20 borax, and 20 starch.

STARCH MANGLES.

Usually made with one brass and two sycamore bowls, mounted in slide blocks, adjustable by vertical screws. The bottom bowl is partly immersed in the starch trough, and as the cloth leaves the machine the superfluous starch contained therein is removed while passing between the nip of the rollers.

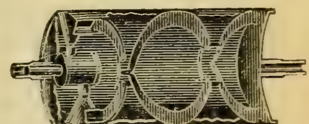
CYLINDER DRYING MACHINES.

Made with two rows of cylinders, one above the other, arranged horizontally or in tiers, and supported by columns when the space available is limited. They are fed by the cloth passing through expanders. The cylinders are steam-heated, and the cloth passes under and over each one alternately. At the delivery end the cloth is plaited down by an ordinary oscillating apparatus.

To obtain the best results, it is essential that the steam, when entering the cylinder, should act directly upon the metal shell, without having to overcome the resistance offered by any film of water that may surround the cylinder.

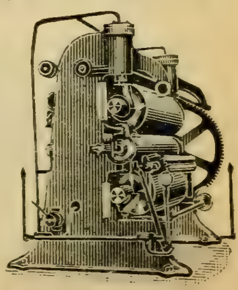
To attain this object, cylinders are made in which a sort of water ejector is provided, in the form of a spiral-shaped open gutter or channel, which commences at one end of the cylinder and makes a series of coils towards the opposite end. The channel is connected at the discharge end with a reservoir or bucket, having an outlet branch projecting into the trunnion of the cylinder.

The above object is also attained by providing within the cylinder helically disposed webs, mounted in contact with the inner surface, and crossing each other. According to the direction of rotation, one or other of these webs conducts the water to a vertical conduit at its extremity. These conduits lead to a chamber at the centre line, where the water is trapped and is compelled to



emerge by way of the delivery trunnion. At the points where the webs cross, means are provided to prevent transfer of the fluid to the opposite web, and to ensure its being carried forward.

DUPLEX SCHREINER CALENDER.



The main features of this type of calender may be described as follows :—The bearings for the steel bowl are fixed, provision being made for taking up the wear of brasses and for easy lubrication. The top and bottom bowls are fitted with independent hydraulic apparatus. Both sets of apparatus can be worked together or independently. The hydraulic apparatus is so designed that the operative can concen-

trate his whole attention in watching the cloth, relieving and reloading either nip instantaneously whenever necessary, and separating the bowls as soon as the batch is finished. The hydraulic pump is driven from calender and fitted with automatic knock-off. A double output is secured for the same cost of power, gas, and labour. The steel bowl is preferably heated by gas, and if sufficiently hot will allow a speed of 15 to 25 lineal yards per minute, thus giving an output of 30 to 50 yards per minute.

CLOTH EXPANDERS.

Function.—To stretch or widen out cloth as it passes in the open state from one machine to another in the bleaching and finishing processes.

Types:—

(I.)—In which a series of sliding racks are employed, which are mounted in halves circumferentially. The racks carry studs, which enter a cam race, and are caused to move towards and from each other as they are moved round the spindle by the pull of the cloth.

(II.)—In which conical bowls are employed. These are mounted axially, so that when the cloth is passed over the surface the increasing diameter of their outer ends causes the cloth to be pulled outwards.

(III.)—In which the expander is made up of a series of curved bars, upon which are mounted short revolving blocks. The curvature of the bars constitutes the expanding force upon the cloth.

Belt Stretching.

For stretching the cloth in order to obtain its utmost width before calendering and finishing, the stretching pulleys are covered with perforated brass or indiarubber, and can be adjusted by means of regulating screws.

BEETLING MACHINE.

The cloth having been wound upon cast-iron beams, it is subjected to a rapid succession of elastic blows from a series of hammers in a Beetling Machine. Beetling machines are of three types:—

(I.) **Wiper Machine.**—The hammers are lifted by a wiper beam, and allowed to drop by their own weight.

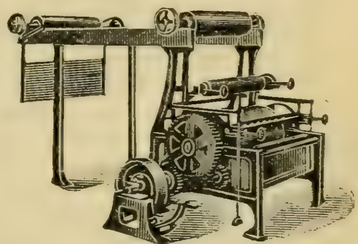
(II.) **Spring Machine.**—Each hammer-head is suspended on belts tightly stretched round C springs. As the beetling proceeds, the beam carrying the cloth is slowly started, and is moved endways in its bearings by suitable mechanism.

(III.) **Pneumatic Machine.**—The hammers are each provided with a pair of cylinders, one of which is used as an air compressor and the other as a ram. The head of the ram is fitted with a block of beechwood, and acts as the hammer which comes in contact with the fabric. A series of eccentrics are employed, each having a double throw to operate the two pistons.

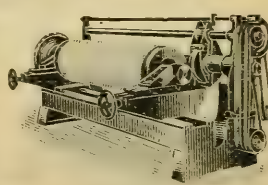
BACK STARCHING MACHINE.

Function.—For starching certain classes of bleached cloth requiring stiffening on one side only.

Description.—The machine has one large roller in the starch-box, generally about 24 in. diameter, made of sycamore. A metal doctor is fitted at the back to regulate the amount of starch to be put on the piece. The cloth is passed first over tension rails, and then through the starch, the side not to be filled being against the face of the bowl. An india-rubber doctor is applied against the bowl surface to ensure that the bowl is kept perfectly clean. Both doctor shears work in blocks and slides. A wooden beater is fitted into the box to drive back the starch, which would otherwise accumulate at one end of the box through the revolving of the large roller. Batching-off brackets are used, and plaiting-down tackle. The driving is generally by means of a pulley and friction clutch, or by fast and loose pulleys; the former is, however, to be preferred.



CALENDER BOWL GRINDER.—By using this machine, bleachers, finishers, and others can true-up their calender bowls on the premises, and thus save the expense and loss of time in sending them to the makers. The machine is provided with sliding carriages and adjustable steps, to take in the necks of the bowls. The surface of the bowl is ground by a revolving wheel mounted on a strong tube. The wheel is traversed by a screw, and is controlled by a reversing arrangement. The length of the traverse is determined by stop-brackets, which are fixed at the required distance apart to suit the length of



bowl to be ground. The bowl is brought into position for grinding by two hand-screws, each of which is fitted with a micrometer dial or collar, graduated to 1/1,000th of an inch. The divisions are numbered to correspond with each other, so that whatever setting takes place it can be done with accuracy.

Speeds.—Driving pulley 10 in. dia., 300 revs. per min.

PNEUMATIC CLOTH FEEDER.

Function.—To dispense with hand labour in feeding the stenters of finishing, printing, drying, and mercerising machines.

Description.—Is a combination of guider and feeder for the cloth, which is attached to the framing of the stenter. The feeder is provided with guide rollers which are actuated by compressed air, so that as the selvedge of the cloth runs between these rollers it comes into contact with a lever which in turn controls the supply of the air, and thereby puts the guide-rollers in and out of action as required.

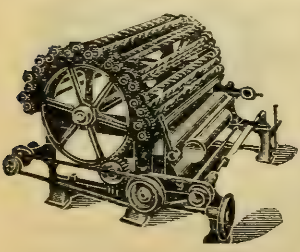
The compressed air is obtained from a Compressor, which is self-contained, and can be placed in any convenient part of the works. About 30 lb. pressure is used, and one compressor will serve three or four feeders.

In some cases (where the cloth is run continuously in the open state, or when the cloth enters straight-running self-closing clip stenters) the guider alone will often suffice.

CLOTH "MELLOWING" MACHINE.

Function.—Breaks down or "mellows" over-calendered or over-finished cotton goods.

Description.—Consists of a series of scrolls arranged in pairs, and mounted in a cylindrical framing. One



scroll of each pair is right-handed, the other left-handed: thus the cloth in passing through the machine is kept central. Half the scrolls are mounted in fixed bearings in the framework; the other half (the outer ones) are mounted in adjustable bearings, and may be made to take up any desired position either in advance of or in the rear of the fixed scrolls. This movement is effected by means of toothed quadrants, which engage with large

setting-wheels at each end of the scrolls; the adjustment being made by means of a hand-wheel and worm gear.

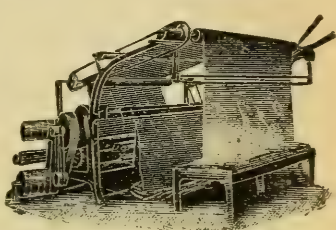
WATER SPRAY DAMPING MACHINE.

Function.—To prepare piece-goods for printing, etc., by applying a little moisture thereto in order to make the fabric limp and bring it into suitable condition for being operated upon.

Description.—The machine is arranged to damp the cloth by a very fine spray, which is obtained by means of a powerful blowing apparatus forcing air against a series of water tubes. The cloth is presented to the machine in the roll, whence it is passed over the damping apparatus, and finally discharged at the delivery end of the machine, either rolled up again or plaited down in folds.

CLOTH RAISING.

In raising cloth for producing what is known as flannelette there are two types of machines used, namely—those worked on the vertical principle and the cylindrical machine.



The vertical or upright machine is adapted for dealing with hard woven cloth and such other fabrics as require little more than a scratching of the surface, commonly termed a **Shirting Finish.** There are usually 8 card-covered rollers, driven by endless belts. To ensure perfect grip of the belts upon the pulleys at the ends of the rollers, the peripheries of the pulleys are covered with a layer of cork.

Cylindrical Machine.

The cylindrical machine is the most universally adopted, as by its action the nap of the cloth is raised to a degree almost equal in effect to the softest flannels. These machines are made with 12, 24, and 36 rollers, and each roller is covered with a special wire clothing. These rollers have imparted to them a two-fold movement, which with their relation to the axis of the main driving shaft forms a sort of "planetary" motion. The rollers, which collectively constitute the cylinder, are divided into two equal sets, arranged alternately over the circumference, and are termed "pile" and "counter-pile" respectively. The pile rollers are

covered with card filleting, having its teeth inclined in the direction in which the cloth is coming, whereas those of the counter-pile rollers lean in the opposite direction. The whole series of rollers are caused to rotate upon their own axes and in the direction opposite to that in which the cloth is moving. The pile rollers raise the nap on the cloth, as do also the counter-pile rollers; moreover, the latter, in addition, impart the required appearance to the cloth. The rollers are mounted in suitable rings, and are caused to rotate round the axis of the main driving shaft; they move in the same direction as the cloth, but at a much quicker surface speed backwards. The cloth as it enters the machine is drawn to the raising cylinder by means of rollers, but before being operated upon it is passed over a steam-heated copper cylinder. The object of the latter is to warm the cloth and prepare it for the raising operation. After raising, the cloth is guided over rollers and plaited-down in the usual manner.

Pulley.—36 in. dia. × $5\frac{1}{2}$ in. wide.

Speeds.—

72 in. machine, 85 revs. per min.
80 in. ditto, 80 revs. per min.
85 in. ditto, 75 revs. per min.

A five-speed slip cone is applied to each machine for varying the speed of the cloth as it goes through.

Floor Space.—72 in. machine, 12 ft. × 13 ft. 8 in.; 80 in. ditto, 12 ft. × 14 ft. 4 in.; 92 in. ditto, 12 ft. × 15 ft. 4 in. Height of machine, 7 ft. 7 in.

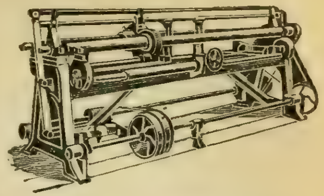
Production.—

24-roller machine—5,000 to 6,000 yards per day.
40- ,, —9,000 to 10,000 ,,

Upright Machine.

Pulley.—12 in. dia. × 4 in. wide.
Speeds.—240 revs. per min. **Power.**—$3\frac{1}{2}$ I.H.P.
Floor Space.—10 ft. × 7 ft. 4 in. × 7 ft. 3 in.

Grinding Frame.—For grinding and pointing the wire clothing of the raising rollers. Is usually provided with two grinders (one on each side of the machine), so that two rollers can be operated on simultaneously. The grinders are caused to traverse longitudinally by means of an overhead screw and block. The screw is fitted with reversing mechanism, which can be regulated to grind various lengths of rollers. The rollers are placed in



steps, which are provided with means for adjustment. One of the grinders is fitted with a boss, upon which are a number of consolidated emery wheels or rings, having bevelled edges for use when grinding the sides of the card teeth.

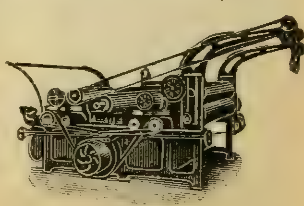
The roller, having been side-ground, is caused to revolve in the opposite direction to enable the emery wheels to follow the spiral grooves of the card fillet. When this is completed the roller is transferred to the other side of the machine, to be surface-ground and trued-up by the second grinder, which is covered with ordinary emery filleting. **Pulleys.**—12 in. × 3 in. **Speed.**—300 R.P.M.

DUST REMOVAL.—The dust produced by raising machines is chiefly of a fibrous nature, having a tendency to "bunch" together and fall to the ground immediately below the machine producing it. Being light, a slight draught will readily blow it aside, with the result that it will spread in a short time throughout the room. With a properly designed system of dust collectors this spreading can be entirely avoided, and the atmosphere and the floor of the room kept perfectly clear.

A sheet-metal shoot, with the sides sloping towards the mouth of a suction duct, should be arranged underneath the machine. The material will fall by gravity towards the duct, and coming under the influence of an air current produced by a fan, is readily removed. The under part of the machine should be closed in as much as possible.

FINISHING MACHINE FOR RAISED FABRICS.

Function.—To produce a high-class finish on raised goods, and to impart thereto a soft milled feel similar to that of flannel, by a combination of steaming, brushing, lustreing, and pressing.



Description.—Is arranged to operate upon the cloth either on one side or both, and the processes can be worked individually or collectively, according to the requirements of the finisher.

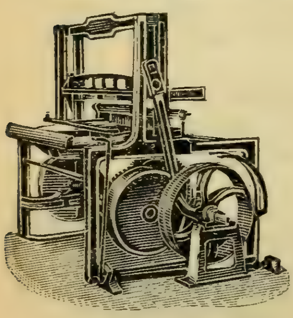
On entering the machine, the cloth to be operated upon is passed over a square bar, down through a pair

of adjustable stretching rods, over a pipe charged with steam, and into a steaming box made of sheet zinc. This box contains two brass rollers to guide the cloth round a perforated steam pipe, which latter is continually emitting steam upon the surface of the cloth. After steaming, the cloth is carefully brushed by means of two revolving brushes, one of which is of wire and the other of bristles. The function of the former is to strike the cloth and loosen the nap, and that of the latter to brush it straight. Brushing is next done on the opposite surface of the cloth by revolving brushes similar to those already mentioned. The cloth is next guided through a damping box, consisting of a perforated steam pipe and trough, from whence it passes to the finishing or lustreing apparatus. This latter consists of a copper cylinder, about 12 in. in diameter, charged with steam. The surface of the cylinder, which is perfectly smooth, comes into contact with the nap side of the cloth, and by rotating in the direction opposite to that in which the cloth goes, a fine lustre is produced upon the fibres. The cloth is finally conveyed over a plush-covered drag roller to a pair of calender rollers, one of which is heated by steam.

PIECE-GOODS STAMPING MACHINE.

Function.—To mark goods so that purchasers may be able to identify them through the various stages of commercial handling. Mostly used by bleachers, dyers, printers, and finishers.

(I.) **Pad Machine.**—For printing trade marks and designs on folded piece-goods with ordinary copper wire

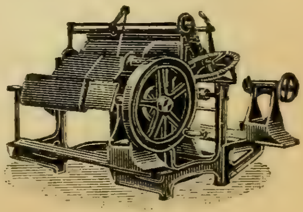


block stamps. The stamps are secured by screws to a slotted platen or beam, and are raised and lowered by means of connecting rods and cranks. At alternate descents they receive colour from the pad and make the impression on the fabric. The colour box and the goods to be stamped are placed on the opposite ends of a table, to which a to-and-fro motion is imparted. The colour pad is first moved into position beneath the stamps, which then receive the colour, and at the next descent make the impression on the fabric, which has in the interval been placed in position by the automatic movement of the table. The table has a momen-

tary rest while the stamps are receiving the colour, and also while the impression is being made on the goods. The front portion of the table is provided with a gauge to set the pieces in correct position. Will stamp from 600 to 900 pieces per hour.

(II.) **Machine for Engraved Stamps.**—The stamps are flat, and are secured by screws to a slotted beam or platen, from which they can be readily removed. The platen is raised by means of connecting-rods and cranks, and in its ascent makes a quarter of a turn, bringing the stamps into a vertical position. In this position they pass in contact with the colouring rollers. On their descent they return to their former position and make the impression on the cloth, which is placed on a stationary table beneath the stamps. Will stamp from 600 to 900 pieces per hour.

(III.) **Table Machine.**—Is provided with a table to receive the goods to be stamped, which is adjustable to take in any thickness of piece up to 8 or 10 inches. This table is provided with slots holding movable pieces, which can be adjusted to suit the width of the cloth. A corresponding table on the opposite side of the machine carries the ink pads. On the top of the frame, at either side, are two slides, on which are mounted a block beam for carrying the stamp blocks. This beam is attached to two arms, one at either side, which have their fulcra at the lower part of the machine. A bowl on each arm connects them with a cam on the driving-wheel. By the revolution of this cam the stamp-block beam is traversed backward and forward over the ink-pad tables and the piece respectively. On the opposite side of the cam-plates is a second cam, which alternately raises and lowers the piece and ink-pad tables. When the piece of cloth has been placed upon the table (the blocks having been previously inked) the stamp-block beam is brought over it. The table then ascends, carrying the piece against the blocks, and is thereby stamped. The table then descends, and the beam moves backwards to get another supply of ink ready for the next operation.



CLOTH MEASURING MACHINES.

Function.—To save time and labour in measuring and in making-up cotton fabrics.

I.—In which the cloth to be measured is first guided over a

rod, and then under and over two stretcher-bars, which take out the creases and keep the fabric at its full width. The cloth next encounters the measuring apparatus, which consists of a friction bowl with its circumference equivalent to either yards or metres. The bowl is caused to revolve by contact with the cloth. On the shaft carrying the friction bowl is a bevel wheel, which gears into one mounted upon a spindle connected with an indicator, upon the dial of which the length is registered. The measured cloth is then wound over lap rods or wound round a roller; or it may be plaited-down upon a suitable table. A stop-motion brings the machine to a standstill when the last portion has passed under the measuring apparatus. This stop-motion consists of a small runner, held at one end of a bell-crank lever mounted upon the axle of the measuring bowl. The opposite end of this lever acts as a brake when in contact with the rim of the measuring bowl. As long as the cloth is passing underneath, the runner is held in support and the brake is out of contact; but when that support is removed, the arm of the lever falls and the brake operates.

II. A machine which measures the length of a piece of cloth and inserts therein small metal discs at the required distances apart. When measured, the cloth is delivered either in the roll or wound upon blocks. The discs are numbered consecutively, so that at such times as stocktaking, sales, etc., the length of cloth remaining on a roll can be ascertained without the necessity of having to unroll the material by hand. The machine is also fitted with an Indicator, which records the length of fabric run off, and serves as a check to the discs.

III. In which an apparatus is provided for automatically inserting or interfolding a strip of paper, marked with a scale of linear measure. This method also enables the operator to read at a glance the exact length of residue remaining on a lap of cloth, without the necessity of unrolling the piece. It is also provided with a special gripping attachment for preventing the overlapping of the cloth selvedges.

RIGGING AND FOLDING MACHINES.

Function.—To save time and labour in making-up wide piece-goods in a convenient form for handling and despatching to the warehouse, cloth merchant, or dyehouse.

Description.—Rigging and folding machines are made for dealing with three classes of work, namely:—

(I.) As a combined machine for doubling and folding only.

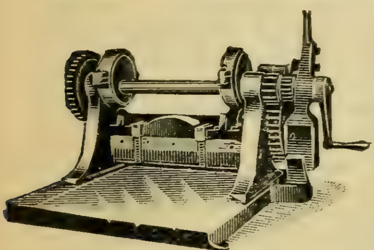
(II.) The above machine provided with a detachable table, which fixes on the folding to permit of narrow goods being folded if required.

(III.) Adapted for rigging and rolling, the rolling apparatus being fixed at the delivery end of the machine.

Production.—Such machines will perform the two operations of rigging and folding, or rigging and rolling, simultaneously, at the rate of 40 yards per minute.

PATTERN AND CLOTH CUTTING MACHINE.

Function.—To cut cloth into small pieces for use as pattern samples by merchants, agents, and others.



Description. — The machine is provided with a knife, which by means of a hand-lever is caused to travel from its top position through several thicknesses of the fabric. The course of the knife is guided between slots cut in disc-plates fixed at the sides of the machine. The machines are made in various sizes; they can be worked either by hand or power, and will take in cloth up to 32 inches wide and in layers up to 1½ inches thick.

Cloth Cutting Machines.—For cutting superimposed layers of cloth to be made up into wearing apparel, etc. There are several makes:—

(1) In which an endless band-knife is used, after the manner of a band-saw.

(2) In which a vertical knife is used, having a quickly reciprocating movement, derived from either crank or cam mechanism. This machine is portable, and is particularly adapted to the cutting of goods under circumstances where a solid front is presented to the cutting edge of the knife.

(3) Another portable machine, but worked with a rotary disc knife having a high velocity. This machine has a wide range of adaptability, and will cut small

quantities of material and such goods as are of a soft nature and readily yield to pressure.

For the second and third machines electricity is a convenient motive power to adopt.

IMITATING THE COLOUR OF EGYPTIAN COTTON.

The long-stapled sorts of American cotton are the most used for producing imitation Egyptian cotton, although occasionally waste Sea Island cotton is employed. The method of procedure varies very much, and the colour may be imparted to the white cotton by dyeing or by steaming. One method consists in choosing those varieties of cotton that are tinged slightly yellowish and known as stained cotton, and spinning without mixing with white cotton. This course is, however, the least recommendable, because the stained sorts usually contain a large proportion of diseased fibres without any sheen, and the resulting yarn has little strength. Another method rests in dyeing the long-stapled fully good middling and middling fair American sorts in the loose state, sliver, or yarn, using for the purpose the direct dyestuffs or the old cutch method. Suitable as cutch is in all other respects, it must be remembered that it makes the cotton somewhat harsh. Dyeing in the loose state and sliver calls, of course, for the provision of special dyeing machines and drying arrangements. It is a method, however, that is suited to the handling of the shorter-stapled qualities. A further way rests in spinning yarn from the finer long-stapled Americans, and subjecting the yarn to a course of steaming.

This is best done in the cop form. The cops are placed in a basket in the steaming chest, which should be so constructed that a partial vacuum may be formed within it for the purpose of drawing the air from between the threads of the yarn. Then the cops are steamed under a pressure of 1 to 1½ atmospheres for a period ranging from a few seconds upwards. The time and pressure influence the depth of tint imparted to the yarn. The time required varies according to the counts of the yarn; for a pale tint on 20's, 25 seconds at the atmosphere will suffice, whereas 30's will require 35 seconds, and 40's 50 seconds. Darker tints call for higher pressure and more prolonged treatment. Nothing definite can be laid down in this respect, however, because of the varying circumstances, and each case therefore must be judged by itself after a trial as to the time and pressure required

to give the desired result. It should be noted that direct sunlight is liable to affect the colour obtained by steaming. Droppings of condensed water are also harmful. A pressure above $1\frac{1}{2}$ atmospheres is likely to weaken the strength of the fibre. Steaming is the most used method of tinting white cotton to resemble Egyptian.

SOME RECENT WORK.

Recent work as exemplified in the articles appearing regularly in the numerous journals devoting attention to the subject of dyeing and its allied branches marks progress, and it is of some interest to refer briefly to some of the articles which have lately appeared.

Purification of Water has received some attention. To purify water before use, by means of lime, or lime and soda, and then to soften completely by passing it through a "permutite" filter is pronounced as a course of procedure which rests for its recommendation altogether on the low cost of the converting bodies, since the caustic soda formed in the process destroys the permutite. Heermann has given some attention to the deterioration suffered by textile goods during a term of storage, and has discussed the origin of the defects, their effects, means of protection, and their recognition. He refers to the tendering of weighted natural silks, the tendering of nitro-cellulose artificial silk, cases of tendering due to decomposition of the colouring matter, the forming of uneven colourings, red stains on silks, the greening of aniline blacks, the yellowing of whites, changing of shades through atmospheric influences, metal stains, alteration of lustre, and feel of the goods.

Lloyd writes in the "Jour. of the Soc. of Dyers and Colourists" on faults in the **dyeing** and **finishing** of **silk.** Silk boiled with soap was examined under the influence of sulphate of soda, nitrates, chlorides, bromides, iodides, and chlorates. Of the neutral salts, the chlorides, bromides, and the weaker iodides, and all these in the presence of oxygen, exert the most damaging influence on the silk fibre. The influence of neutral salts on silk or on silk glue is especially noticeable on incompletely boiled-off silk. Many of the stains which appear on white

or cream-tinted silk are often due to the nature of the soap and its incomplete removal from the treated material. The use of acetic acid in the finishing operations may also cause trouble in the presence of soap.

A French patent (457,706) describes a method of applying the basic dyestuffs from a liquor acidified with mineral acids, by which, through boiling for one to two hours, the **material** may be **dyed right through.** Other articles have been concerned with the dyeing of carpet yarns, particular reference being made to the scouring of the wool, dyeing with the acid and mordant colouring matters, bottoming with indigo, and also the dyeing of **carpet yarns** composed of cotton, linen, and jute. Attention has also been given to the dyeing of **shoddy** containing cotton with the acid-dyeing alizarine dyes, topping afterwards with the substantive dyes, and diazotising and developing, or after-treating, with formaldehyde or metallic salts. Working is also described with the sulphur dyes in the presence of di-sodium phosphate or borax, bisulphite of soda, and a mixture of lactic acid and lactates. Regarding the dyeing of **cotton,** G. Dorr and Co. claim the use of silicate of soda with the direct dyes in one bath without other addition and without previously wetting out. The material is treated for an hour at the boil. Dyes which do not admit of the presence of alkali may be applied after first boiling the cotton in a solution of the silicate of soda and then adding the dye solution. It is claimed that the material when treated with silicate of soda increases in weight and acquires the so-called harsh cutch feel, which may, however, be removed by a suitable softening agent.

The treatment of **wool** (the Becke-Beil process) with tannin and metallic salts to cause it to resist the absorption of substantive colouring matters in the course of dyeing woollen and half-woollen fabrics with **artificial silk** effect threads has been dealt with at some length by Schmidt in the columns of the "Zeitschrift für Farben Industrie." The wide possibilities of the method are enlarged upon. A method, patented by Weller (German 266,343), for the production of dyeings fast to friction, water, and washing, consists in dissolving a suitable colouring matter in a volatile organic acid, not less than 20 per cent., and treating the material with this solution. It is then allowed to lie until the acid has volatilised, and the resulting colour is said to exhibit the properties claimed.

The same inventor describes a process (German 266,708) for the **through-dyeing** of goods usually difficult to penetrate by steeping the dry material for some time in an indifferent but easily volatile compound, such as ether, benzene, carbon tetrachloride, dichlor-ethylene, etc., and then renewing the solvent and dyeing in a fresh hot liquor. A process (German patent 265,832) for the production of stable concentrated preparations of indigo-white and salts of **indigo-white** specially required for Eastern vats, with which are mixed molasses, syrup, or the sugars, is suggested by using, instead of these bodies, lactic acid, or its salts. This process is also applicable, according to later work, to the treatment of other leuco vat dyes and the leuco sulphur dyes. The Summers Linen Co. (American patent 1,064,393) describes a method of applying the **vat dyestuffs** by dissolving the colouring matter in a sulphide and reducing agent, such as hydrosulphite. It is claimed that more level dyeings can be attained, and with less dyestuff and hydrosulphite, than when dyeing is accomplished under the addition of alkali.

Dominguez, of Buenos Ayres (British patent 4,248, 1912), employs for dyeing silk, wool, and cotton, the extract of the white or black **algaroba** tree (prosopis alba or nigra). By after-treating the dyeings with metallic salts, shades ranging from red to slate are obtained. O. N. Witt discovered the preparation.

Read Holliday and Sons, Huddersfield, have patented a method of **after-treatment** of dyeings with the direct black cotton dyestuffs by treating with para-phenylene-diamine in the presence of an oxidising agent. Brighter shades are thus obtainable than without the after-treatment. The same firm have claimed the use of thiosulphate of soda for improving the fastness to light of dyeings with the direct dyestuffs.

RECENT PROGRESS IN CONNECTION WITH THE VAT DYES.

In the " Farber Zeitung " Erban compiles a list of the recent work concerning the vat dyes generally, the methods of reducing, and their after-treatment.

General Work : Much attention has been given to the vat dyes by the technological press. In the new edition of the "Chem. tech. der Gespinnstfasern," by Georgievics, Grandmongin writes a chapter on those of industrial importance. The practical difficulties of vat dyeing have

been referred to in many journals, and especially by Krostewitz and Tagliani in regard to indigo blue. The difficulty of matching to shade with the vat dyes has been discussed by Eppendahl. Ermen has investigated some of the properties of their fastness. A vacuum dyeing machine for loose material has been described by Rohrig, in which the vat liquor is kept in circulation by two propellers. The machine of Rachou and Chaumatin (English patent 1,247, 1911), invented for applying indigo, has been protected (English patent 2,735, 1912) also for other vat dyes. The estimation of indigo on the fibre in the presence of other colouring matters, exclusive of the newer vat dyes, has been studied by Green, Gardner, Lloyd, and Frank, who use acetone, pyridine, benzaldehyde, or a mixture of cresol and carbohydrates for removing the indigo. Barnes has described a method for the estimating of indigo colorimetrically.

Reduction Methods: The preparation of the vat dyes in a finely divided state has been accomplished in various ways. Meister, Lucius, und Brüning oxidise the formaldehyde-indigo-white in the presence of alkali with air (German patent 246,580). The Badische effect an improvement by forcing a blast of cold air through the vat liquor of indigo and thio-indigo compounds in the presence of sulphite cellulose lyes. The same firm describes (German patent 253,509) the preparing of finely divided indigo by oxidising the leuco-compound with nitro-bodies or quinones. The vat dyes have been recommended for use also as pigments.

To give to artificial indigo for export a form similar to natural indigo and its characteristic brittleness, the paste (B.A.S.F., 69,458) is mixed with a solution of sulphate of alumina and the alumina precipitated with silicate of soda; glue, dextrine, and sugar are used as binding agents. A process of preparing indigo white under the addition of hygroscopic salts, calcium chloride, and potash is the subject of an invention (German patent 61,572). Preparations suitable for the fermentation vat are made (Badische) by heating indigo derivatives with benzoyl chloride. The preparation of indigo white by reducing the indigo with caustic soda and silicium is the subject of an invention (M. L. & B.). The Diamalt Co. recommend (German patent 27,094) diastase for fermentation vats. For the improvement of indigo vats Brown recommends an addition of monopol soap and sulphate of soda.

Application to Animal Fibres: The vat dyes have been specially recommended for the dyeing of wool for military cloths. The heliodone dyes may be applied to wool by the addition of oil preparations to the vat liquor (Kaemmerer). Meister, Lucius, und Brüning particularly recommend thioindigo blue 2B, thioindigo yellow GW, and thioindigo brown R for wool. Whereas the indanthrene colours have hitherto been regarded as not suitable for the dyeing of wool because of their strongly alkaline liquors, brands are now offered (Badische)—indanthrene yellow GN, gold-orange RN extra, red BN, and red-violet BN—that are serviceable for the purpose. For the dyeing of silk the addition of soap and turkone oil to the liquor is recommended. With the same object Wedekind uses the magnesium salt of the leuco compound.

THE FINISHING OF FABRICS PRINTED WITH VISCOSE

Fabrics printed or coated with viscose have hitherto been subjected, for the purpose of finishing, either to the influence of steam, dry heat, hot water, or acids alone or admixed with sugar and glycerine, or with acids and their salts, or with salts alone (sulphate of ammonia, ammonium chloride, common salt, etc.), or with bisulphite solutions, or with salts of the heavy metals, or even the alcohols, and submitted next to a course of washing for freeing the insolubilised viscose from the impurities it may contain. It has been observed (German patent 257,459) that the treatment of fabrics of this sort with the salts or double salts of alumina or with compounds of aluminium soluble in water, acids, or alkalis, marks an important progress over the old methods, because the combination or viscose, or rather of the cellulose or hydrocellulose regenerated in part from it, is more intimate, and in consequence the fastness and stability is augmented as well as the brilliancy and scroop of fabrics treated by the new method. In this process the fabric covered with raw or purified viscose by any of the methods at present to be mentioned is introduced, either in the dry or slightly damp state, into a liquor consisting of a solution of a salt or alumina (alum, for instance). It is permissible to add to the liquor agents for effecting the fixation of the viscose, such as mineral or organic acids, or other bodies known in practice as fixing agents of viscose, such as glycerine and the carbo-hydrates.

If the cloth treated with viscose be sent through any of these solutions, without preliminary insolubilisation, it is necessary, if the liquors do not contain additions exercising a fixing action on the viscose, to augment the proportion of alumina compounds so as to assure insolubilisation. The duration of the treatment with the liquor is variable according to the following factors: It depends very much, obviously, on the initial state of the viscose—soluble or not. For instance, when employing a solution containing 20 or 30 per cent. of sulphate of alumina without other additions, the duration of the immersion may vary from five to thirty minutes according to the thickness of the desired coating. In all cases it is necessary to wash thoroughly, first with cold water, then warm, and finally with boiling water.

THE DUVETYN FINISH.

The Duvetyn finish, which is produced on cotton fabrics by what is known as "**emerising,**" is a somewhat recent novelty in the way of finishes. It has enjoyed a run of popularity, and is still in favour. At the time of its introduction it was worked as a secret process, different finishers employing methods differing perhaps in some detail or another. Experience with the work has brought improvements, and one of these forms the subject of an invention by the Société Dubar-Delespaul, of Roubaix (French patent 449,266, 1911). It is an application of a well-known process of raising or "emerising," and it is stated by the inventors that the patent involves no improvement in the technique of that process. The "emerising" process is used generally on cotton goods woven in such a way that the weft floats on the face of the cloth and the warp on the back, much the same as a moleskin. This process of finishing does not require any special treatment in the weaving, and is equally well adapted for worsted or carded woollen fabrics as for cotton. The fabrics are emerised either in the grey or after dyeing or printing. The process changes the surface of the cloth—gives it the appearance of velveteen, chamois, or the skin of the mole. The operation is very simple, and consists in subjecting the cloth in two or three passages to the action of several rollers which revolve rapidly in a direction opposite to that in which the cloth is moving. These rollers are covered with emery cloth.

Pulverised flint, stone, glass, or sand may be substituted for the emery. The action of the roller on the weft of the cloth produces a very short, thick nap, with the fibres standing straight from the surface of the cloth. The extent of this action depends, of course, on the nature of the fabric to be finished, and is regulated by the tension of the cloth, the speed and number of the rollers, and on the fineness of the emery with which the rollers are covered. It is evident that carded woollen goods can be finished by this process more easily than worsteds, owing to the difference in the twist of the yarn. Emerising differs radically from napping or raising on the ordinary raising machine: the latter tears the fibres from the thread in order to form the nap. Emerising consists not in tearing the fibres out, but in wearing or polishing the surface. Both raising and emerising, however, serve the purpose of reducing the strength and solidity of the fabric. In order that the nap may be uniform it is necessary that the fabric should possess a certain degree of stiffness. For this reason the cloth is heavily sized, and this prevents the action of the emery penetrating deeply into the fibres. The ordinary glue used in finishing answers the purpose, and after it has been applied the material is dried thoroughly before emerising. By covering the rollers with bands of emery the Duvetyn finish can be produced in the form of stripes.

THE MERCURY-VAPOUR LAMP FOR TESTING LIGHT-FASTNESS.

The ever-increasing demand for colours that are fast to light, on dyed and printed materials, forces the textile colourist to meet the situation, and with a right choice he need have no great fear in selecting colouring matters that are suited to the requirements from the extensive series now available. Nevertheless, it is advisable that the textile colourist, the manufacturer, and the merchant should satisfy themselves as far as possible as to the fastness of some colours by the results of confirmatory tests.

Within recent years the mercury-vapour lamp has been put on the market. Although the rays of light it gives do not imitate sunlight, they have a very strong bleaching action on colours, and when carefully and judiciously used the lamp may give very good results. As is well known, the rays of light in sunlight which affect the

colours (the ultra violet or chemically active rays) lie in the violet end of the spectrum—and the light from the mercury-vapour lamp is very rich in these chemically active rays.

The lamp itself consists of a tube of quartz which allows the chemically active rays to pass. This tube is filled with mercury, which becomes incandescent on the current being passed, and this mercury vapour in an incandescent state gives off the rays of light which have such strong bleaching effects.

A great advantage claimed in the use of this lamp is that experiments on the fastness of coloured materials can be made at any time of the year, and provided note is made of the duration of exposure and the distance of the lamp itself from the sample, corresponding tests can be made at any other time.

It will be found that (depending on the shade) an exposure of from 30 to 100 hours approximately under the lamp is equivalent to one month's exposure in sunlight during the summer. When working with this lamp it is necessary to divide the shades to be tested into two main groups—blues and greens in one group, reds and yellows in another. This lamp affects blue and green shades more rapidly and with greater force than red or yellow shades, and therefore to get an accurate result a correspondingly shorter exposure is necessary. A few exposures under the lamp and then comparison with sunlight exposure of the same shades indicate the relative exposure which is necessary. That having been ascertained, corresponding exposures can be made, which will give very accurate results as to the fastness of the colour. It must be understood that even when making allowance for the different times of exposure, results exactly the same as sunlight bleaching cannot be obtained. The shades bleached under the lamp have a tendency to be duller and give more of a change in shade and less of a bleaching effect. This difference is, however, rather slight, and very little when weighed against the manifold advantages which this lamp offers.

All browns and tertiary shades generally are given the longer exposure (100 hours), except in those cases where blue and bluish-green are the predominating colours. With mixtures of blue and red, if the predominating colour is blue, then the short exposure is given; if it is red, then the longer.

SPINNING COLOURED YARNS

Cotton Dyed Loose.—The advantages of working up cotton dyed in the loose state are:—The mechanical arrangements are simple, admitting both of dyeing and subsequent washing. In the dyeing and the drying operations the form of the material is retained, as is also the uniformity of the colour in the worked-up yarn, for the mixing operation equalises any irregularities of shade. After dyeing, the loose cotton may be opened out before drying and eventually dried at a very moderate temperature. So long as the loose cotton has not been carelessly or faultily handled during the dyeing, and no felting or matting has taken place, the fibre yields satisfactorily to spinning after the first carding.

The disadvantages of the above system are the following:—Rational working can be attained only by having large lots to dye at a time, and by choosing rightly the dyestuffs and methods of applying them. When changing a colour on the carding engine, the cards need to be thoroughly cleaned before this can be done, and both time and production are thus lost. Light and bright colours are soiled and dirtied in the passage of the fibre through the several stages of preparation.

Dyed Rovings.—The advantages to be gained are the following:—No complications of the spinning processes; many classes of colouring matters may be used in dyeing rovings which act prejudicially on loose material in the carding operation; small quantities of material may be dyed; and light and bright shades are not subject to the same amount of soiling influences.

On the other hand, the disadvantages of dyeing rovings are:—The mechanical arrangements are very complicated. Great care has to be taken to avoid deformation of the rovings and felting of the fibre, so as not to prejudice the succeeding operations of manufacture. Difficulties are encountered in properly drying the rovings after dyeing, owing to the compactness of the material. High temperatures cannot be used successfully, because the fibre loses some of its working properties; yet drying at low temperatures may have serious drawbacks, in that the inner parts of the roving cause considerable trouble, the fibres sticking through being in a damp condition. Rovings dyed are frequently liable to "dust out," and this rather grave fault is due to the fibre retaining any non-dissolved or insoluble particles of matter, which may have been present in the dyebaths, and which cannot be removed by extracting or washing.

COTTON CLOTH (BRITISH) FACTORIES ACT, 1889.

Maximum Limits of Humidity of the Atmosphere at given Temperatures.

Dry Bulb Readings.	Wet Bulb Readings.	Grains of Moisture per cubic foot of Air.	Percentage of Humidity Saturation = 100	Dry Bulb Readings.	Wet Bulb Readings.	Grains of Moisture per cubic foot of Air.	Percentage of Humidity Saturation = 100
35°	33°	1·9	80	68°	66°	6·6	88
36	34	2·0	82	69	67	6·9	88
37	35	2·1	83	70	68	7·1	88
38	36	2·2	83	71	68·5	7·1	85·5
39	37	2·3	84	72	69	7·1	84
40	38	2·4	84	73	70	7·4	84
41	39	2·5	84	74	70·5	7·4	81·5
42	40	2·6	85	75	71·5	7·65	81·5
43	41	2·7	84	76	72	7·7	79
44	42	2·8	84	77	73	8·0	79
45	43	2·9	85	78	73·5	8·0	77
46	44	3·1	86	79	74·5	8·25	77·5
47	45	3·2	86	80	75·5	8·55	77·5
48	46	3·3	86	81	76	8·6	76
49	47	3·4	86	82	76·5	8·65	74
50	48	3·5	86	83	77·5	8·85	74
51	49	3·6	86	84	78	8·9	72
52	50	3·8	86	85	79	9·2	72
53	51	3·9	86	86	80	9·5	72
54	52	4·1	86	87	80·5	9·55	71
55	53	4·2	87	88	81·5	9·9	71
56	54	4·4	87	89	82·5	10·25	71
57	55	4·5	87	90	83	10·3	69
58	56	4·7	87	91	83·5	10·35	68
59	57	4·9	88	92	84·5	10·7	68
60	58	5·1	88	93	85·5	11·0	68
61	59	5·2	88	94	86	11·1	66
62	60	5·4	88	95	87	11·5	66
63	61	5·6	88	96	88	11·8	66
64	62	5·8	88	97	88·5	11·9	65·5
65	63	6·0	88	98	89	12·0	64
66	64	6·2	88	99	90	12·3	64
67	65	6·4	88	100	91	12·7	64

SECTION IX:

WAREHOUSE

AND

OFFICE:

COSTING
YARN AND CLOTH

MILL BOOKS

ETC., ETC.

"CLOTH-LOOKING"

FAULTY CLOTH AND ITS CAUSES.

The chief faults in cloth caused during weaving are:—

Ends Out.—Undue breakages caused by (*a*) faulty yarn, as thick soft places, thin places, snarls, and knots; quality too low for the cloth to be woven; (*b*) faulty preparation of the warp during warping, sizing, or beaming; (*c*) undue strain on the yarn during weaving by incorrect setting of the loom parts. Broken threads arising from one or other of the above causes may not be immediately replaced by the weaver, and an unsightly place is the result. Looms can now be provided with various motions for automatically stopping the loom on the breakage of a warp thread.

Missed Picks or Broken Patterns.—Are caused by the weaver failing to adjust the tappet, cards, or lags after a breakage of the weft. Broken patterns also result from wrong drafts, pegs falling out of dobby lags, or jacquard hooks not acting.

Floats.—Are chiefly caused by broken ends, long knots, or broken heald or harness cords becoming entangled with a number of adjacent ends, thus interfering with their correct weaving.

Reedy, Bare, or Badly Covered Cloth.—Is chiefly seen in plain cloth or calico, and is caused by the warp threads running together in pairs instead of being evenly separated. This is due to incorrect setting of the warp rollers and incorrect timing of shedding and picking, also to improper tensioning or pacing of the warp.

Bad Selvedges.—Are due to faulty beaming of the warp near the flanges, wrong drafting of the selvedge ends, number of selvedge ends too great or too small, defective temples, and improper tensioning of the weft.

Uneven Cloth, or Thick and Thin Places.—Due to uneven delivery of the warp or taking up of the cloth, by derangement of the letting-off or taking-up motions, or to the incorrect adjustment of the latter motion by the weaver after a failure or breakage of the weft.

Traps or Smashes.—Are caused by the sley moving towards the cloth with the shuttle trapped in the shed or opening in the warp thread, which results in the breakage of a considerable number of ends.

Looped Weft.—Is due to insufficient tension on the weft as it leaves the shuttle, or rebounding of the latter as it enters the box.

Weft Picking Under.—Is due to uneven shedding or improper cording of the healds.

Box Marks.—Are marks or stains made upon the weft by its being caught between the shuttle and box sides.

Oil Spots and Stains.—Are due to the careless use of oil by the weaver or by drippings from the dobby, jacquard, or shafting.

Mildew.—Is a fungoid growth originating from, and subsisting upon, the vegetable and animal substances used in the size mixing. When the latter is properly constituted, it contains substances which will prevent its growth. It makes its appearance upon cloth in furry patches of various colours, chiefly green in England. In the early stages of its development it can be washed from the cloth by ordinary soap and water without leaving any permanent trace; later it leaves a stain or discoloration, but washing with a solution of bleaching powder may remove the marks, otherwise bleaching must be resorted to; and finally it attacks and rots the yarns.

Iron-mould Stains.—Are detected by their rusty appearance. They occur in pieces that have been standing in the loom over the week-end. The decreased temperature of the weaving shed at this period often causes moisture to be deposited on the ironwork of the loom with which the cloth has been left in contact. If caused by contact with the reed, the marks are streaky, if from the breast beam of the loom they show across the cloth.

It is a common practice for weavers to remove oil and iron stains by washing with a weak solution of oxalic acid. The parts so treated are apt to show in patches and sometimes cause the cloth to contract in width. If, however, the acid be thoroughly washed out, no serious injury is done to the cloth.

Pocket Cloth Calculator.—For the use of manufacturers, managers, and salesmen, engaged in the weaving industry. Is an adaptation of the slide rule, and consists of a graduated rotating dial operated by a thumb-key, a rotating pointer operated by a central button, and a fixed datum line. By the aid of a logarithmic scale, multiplication and division are effected by the simple operations of additions and subtractions, which can be represented by alterations in length. This is done by the rotation of a circular scale and the pointer, in relation to the fixed datum line.

GREY CLOTH ANALYSIS

Manufacturers are frequently called upon to weave cloth "to sample" or pattern received from abroad by their agents or merchants. The sample should be carefully dissected, which may be done by the following method :—

Extracting the Threads.—A piece of the fabric (say about 32 inches long) should be stretched upon a table to take out the wavy creases, the end to be dissected being nearest the operator. The warp threads are then removed by the aid of a cutting block, 20 inches long by 8 inches wide. This block is laid over the cloth parallel to the selvedge; and the cloth is cut along the edges of the block, retaining the size above stated. A few inches of this is then torn (not cut) from the selvedge, in order to get a straight edge from which to commence operations. The fabric is now laid over the edge of the table, and 36 of the warp threads are withdrawn, care being taken that all the threads removed are the full length of 20 inches.

The warp threads having been extracted, the cloth is turned round; and, by operating in a similar manner, the weft threads are withdrawn. These latter should be taken from a portion of the cloth farthest from the selvedge.

The warp and weft threads will have slightly increased in length on being released from the web of the fabric, so they are now laid out and cut to the exact length of 20 inches.

Removing Size.—For practical purposes this may be accomplished by boiling in a weak solution of soda, or steeping in a weak solution of acid, followed by rinsing in clean water and drying. With very heavily sized yarn it may be necessary to repeat the boiling or steeping. When a more exact analysis is required, the following method may be adopted :—

(1) Boil the twist and weft threads in clear water for 10 minutes. For this purpose a glass beaker may be used.
(2) Rinse in running water.
(3) Boil in a 2 per cent. solution of salicylic acid ($C_7H_6O_3$) for 30 minutes.
(4) Rinse in running water.
(5) Boil in water 10 minutes.
(6) Rinse in running water.

Now place the threads between filter paper, and afterwards in a receptacle for weighing—preferably a glass jar or bottle. Put this receptacle, with its contents, into a small drying oven, to which is attached a thermometer. Bring the temperature in the oven gradually up to 212 deg. Fahr. On removing the bottle, sufficient time should be allowed for cooling, after which extract the threads and weigh them on a pair of delicate scales.

The net weight of yarn in its dry state having been thus ascertained, add thereto 7.834 per cent., to bring the yarn up to its correct condition.

FORMULÆ.

$$\frac{\text{Length in Yards} \times 100}{\text{Weight in Grains after Stripping} \times 12} = \text{Actual Counts.}$$

The threads having been weighed after dissecting, the difference in the weight of the warp or weft gives the percentage of size on the threads. Thus—

$$\frac{\text{Weight of Size in Warp} \times 100}{\text{Weight of Warp before Stripping}} = \text{Percentage of Size in Warp.}$$

Example—

	Weft.	Warp.
21 yards of yarn, taken from cloth, weight in grains .. .. =	4·13	—
20½ ditto ditto ditto .. =	—	4·73
21 yards of yarn, stripped, dried, added normal moisture in grains .. .. =	4·04	—
20½ ditto ditto ditto .. =	—	4.34
Size in Warp and Weft =	0·09	0·39

0·09 + 0·39 = 0·48 Grains Size on Warp.

$$\frac{\text{Weight of Size} = 0{\cdot}48 \times 100}{\text{Weight of Yarn before Stripping} = 4{\cdot}73} = 10{\cdot}14\% \text{ of Size in Cloth.}$$

$$\text{Weft} \;..\; \frac{21 \times 100}{4{\cdot}04 \times 12} = 43{\cdot}3\text{'s Actual Counts.}$$

$$\text{Warp} \;..\; \frac{20{\cdot}5 \times 100}{4{\cdot}34 \times 12} = 39{\cdot}3\text{'s Actual Counts.}$$

THE COSTING OF YARNS

For cotton yarns the *unit of cost* is the pound (lb.) weight of yarn produced, and all the items of cost must be expressed upon that basis, as so much per lb. of yarn produced. The *items of cost* are:—(1) Raw cotton. (2) Wages. (3) Working expenses. (4) Discount on sale.

(1) **RAW COTTON.**—It is first necessary to ascertain the *weight of raw cotton* required to produce 1 lb. of yarn, and this the spinner will do from his experience of working, or from special tests which he will make. Suppose he has discovered that in the making of a carded yarn the raw cotton loses 16 per cent. in waste (visible and invisible), and that after the yarn is spun it regains 5 per cent. in moisture. Then for every 100 lb. of raw cotton used, there will be produced 88.2 lb. of yarn, as under:—

Raw cotton used	100 lb.
Visible and invisible waste	16
Yarn spun	84
5 per cent. regain	4.2
Yarn produced	88.2 lb.

And if the raw cotton required to produce 88.2 lb. of yarn is 100 lb., the raw cotton required to produce 1 lb. of yarn will be—

$$\frac{100}{88{\cdot}2} = 1{\cdot}134 \text{ lb.}$$

If the yarn is a combed one, the calculation will be the same with an additional allowance for comber waste. Suppose the comber waste to be 20 per cent., then the amount of yarn produced from 100 lb. of raw cotton will be 70.56 lb. Thus:—

Raw cotton used	100 lb.
Visible and invisible carded waste	16
	84
20 per cent. comber waste	16.8
Yarn produced	67.2
5 per cent. regain	3.36
Yarn produced	70.56 lb.

And if the raw cotton required to produce 70.56 lb. of

yarn is 100 lb., the raw cotton required to produce 1 lb. of yarn will be—

$$\frac{100}{70{\cdot}56} = 1{\cdot}417 \text{ lb.}$$

Having ascertained the weight required, the next thing is to ascertain the *value of the weight.* The price per lb. of cotton is the price at which the spinner has bought it, or the price at which it is quoted to him by his cotton broker. With the cotton price at 10d. per lb., the cost per lb. of yarn in raw cotton in the two examples quoted above would be :—

Carded yarn.........	10d. × 1·134 = 11·34d.
Combed yarn	10d. × 1·417 = 14·17d.

A yarn may, however, be made of a mixture of both carded and combed cottons, in which case the calculation becomes a little more complicated. A yarn made from such a mixture (for example) as three-quarters carded cotton and one-quarter combed cotton, would cost in raw cotton, per lb. of yarn produced—

$$\frac{3(10 \times 1{\cdot}134) + (10 \times 1{\cdot}417)}{4}$$
$$= 12{\cdot}047\text{d.}$$

These are the *gross costs* in raw cotton, and there must now be deducted from these figures the amount received for the sale of the waste produced, in order to ascertain the *net costs* of cotton.

In the case of the CARDED COTTON, there are available for sale from every 100 lb. of cotton used, about 13 lb. of waste of various kinds, the remaining weight being lost as invisible waste. From the analysis of waste produced, and from the waste contract, the value of the 13 lb. will be ascertained, as, for example :—

		Price per lb.	d.
Scutcher droppings	3%	¼d.	·75
Card strips...	4%	4½d.	18·
Card fly	3%	1½d.	4·5
Sundry other wastes	3%	3d.	9·
Total...........................	13%		32·25d.

$$\frac{32{\cdot}25\text{d.}}{13 \text{ lb.}} = 2{\cdot}48\text{d. per lb.}$$

Then 13 lb. of waste produced at an average price of 2.48d. per lb. = 32.25d., which is—

$$\frac{32{\cdot}25\text{d}}{88{\cdot}2 \text{ lb.}} = 0{\cdot}365\text{d. per lb. of yarn produced.}$$

In the case of the carded yarn, the net cost of raw cotton is—

$$11{\cdot}34 - {\cdot}365 = 10{\cdot}975\text{d. per lb. of yarn produced.}$$

In the case of the COMBED YARN, with comber waste at 6d. per lb., the net cost of raw cotton is—

$$\frac{32{\cdot}34\text{d.}}{70{\cdot}56\text{ lb.}} = {\cdot}457\text{d. carded waste.}$$

$$\frac{16{\cdot}8\text{ lb.} \times 6\text{d.}}{70{\cdot}56\text{ lb.}} = 1{\cdot}429\text{d. comber waste.}$$

$$14{\cdot}17\text{d.} - ({\cdot}457\text{d.} + 1{\cdot}429\text{d.}) = 12{\cdot}284\text{d. per lb. of yarn produced.}$$

In the case of the yarn made from three-quarters CARDED cotton and one-quarter COMBED cotton, the net cost of raw cotton is—

$$\frac{3(10{\cdot}975) + 12{\cdot}284}{4} = 11{\cdot}302\text{d. per lb. of yarn produced.}$$

It will be noticed that the cost for waste (*i.e.*, the difference between the price of the raw cotton and the cost of raw cotton per lb. of yarn produced) will vary with the price of raw cotton; therefore this item of cost must be worked out afresh every time there is a change in the price of cotton. It cannot be stated as a fixed value irrespective of the price of cotton. It is desirable in practice to have these costs prepared beforehand in the form of tables, so that they may be ascertained at a glance.

(2) **WAGES.**—The basis of the calculation for cost of wages is to take the average total wages of a process for a given period (say one week), and to divide that total by the average total production for the same period.

In a mill spinning one count only, the whole working of the mill can be regarded as one process only, and the total wages of the mill be divided by the total production of the mill.

In a mill spinning more counts than one, however, correct costing can only be obtained by treating the wages of the different processes separately, regarding as one process only all those processes in which the whole production of the mill is treated alike.

For example, in a mill producing ten different counts of yarn from two different hank rovings, each yarn would pass through three processes so far as the item of wages was concerned—

(*a*) Pre-roving process,
(*b*) Roving process,
(*c*) Spinning process,

and in the case of all the yarns the cost in wages of the pre-roving process would be the same.

It is first necessary to find the *average weekly wages* of the mill, and then to apportion them over the different processes. Suppose, for example, in a mill of 100,000 spindles, where all the production is treated alike up to the roving frame, after which different hank rovings and different counts of yarn are made, the average weekly wages are—

(*a*) Pre-roving process	£47
(*b*) Roving process	39
(*c*) Spinning process and general wages......	210
Total wages	£296

These figures must now be stated in some form easily applicable to the production of each process. For example :—

(*a*) Pre-roving processes	450d. per 100 intermediate spindles
(*b*) Roving process..................	90d. per 100 roving spindles
(*c*) Spinning process & general wages	504d. per 1,000 mule spindles.

Great care should be taken to see that the productions are fair average productions, as any error in them will mean an under-estimate or over-estimate of cost. The productions should also include an allowance for *regain*. Suppose the productions to be—

Intermediate Frames: 1,700 lb. per 100 spindles per week.

Roving Frames:

Roving for 50's counts................	460 lb. per 100 spindles per week
Roving for 60's and 70's counts...	350 lb. per 100 spindles per week

Mules:

50's counts..............................	450 lb. per 1,000 spindles per week
60's counts	380 lb. per 1,000 spindles per week
70's counts..............................	310 lb. per 1,000 spindles per week

Then, by dividing the productions into the wages, there will be ascertained the cost in wages at each process :—

(*a*) Pre-Roving Process:

$$\frac{450\text{d}}{1{,}700\text{ lb.}} = \cdot265\text{d. per lb. of yarn.}$$

(*b*) Roving Process:

Roving for 50's $\dfrac{90\text{d.}}{460\text{ lb.}} = \cdot196\text{d. per lb. of yarn.}$

Roving for 60's and 70's $\dfrac{90\text{d.}}{350\text{ lb.}} = \cdot257\text{d. per lb. of yarn.}$

(c) SPINNING PROCESS AND GENERAL WAGES:

50's counts $\frac{504d.}{450 lb.}$ = 1·12d. per lb. of yarn.

60's counts $\frac{504d.}{380 lb.}$ = 1·326d. per lb. of yarn.

70's counts $\frac{504d.}{310 lb.}$ = 1·626d. per lb. of yarn.

Adding together the wages of all the processes, we get—

Counts	50's	60's	70's
Pre-roving process	·265	·265	·265
Roving process	·196	·257	·257
Spinning process and general wages	1·120	1·326	1·626
Total cost in wages ... Pence	1·581	1·848	2·148

(3) **WORKING EXPENSES.**—Under this heading are grouped all charges other than those for raw cotton, wages, and discount. The working expenses of a cotton mill include the cost of leather, oil, repairs, ropes, depreciation, rents, rates, etc. The amount expended upon these items from year to year will not be anything like so constant as the amount expended upon wages. For this reason it is necessary that great care should be taken in ascertaining the figures which are to be the basis of the calculation of costing.

The spinner will have at his disposal from the records of his past working, statements shewing the amount of working expenses incurred. Upon these may be based an estimate of the present working expenses, allowance being made for any known variation in the expenditure, such as an increase in the price of coal, a rise in rates, or an alteration of the depreciation allowance.

Suppose that these expenses for the year amount to £15,000 for a 100,000-spindle mill. There being in the year 50 weeks in which yarn is being spun, then the working expenses per week amount to £300. The question now arises, How shall these working expenses of £300 per week be apportioned over the different processes? In the case of wages, the wage books record the wages of each process; but there is no record of the separate expenses of each process.

A satisfactory method of apportionment is to divide the total working expenses into expenses that vary with the value of the machinery employed, and expenses that vary with the space occupied. Most of the expenses in a cotton mill will fall into one or other of these divisions.

Depreciation, repairs to machinery, oil, etc., will vary approximately as to value of machinery; rents, rates, lighting, repairs to buildings, etc., will vary approximately according to the space occupied.

For example, take again a mill of 100,000 spindles, with the following particulars as to value of machinery and space occupied :—

	Value of machinery.		Sq. yds. occupied.
Pre-roving process	£17,000	...	2,750
Roving process	8,000	...	2,250
Spinning process	25,000	...	15,000
	£50,000		20,000

Taking the amount of weekly working expenses given above (£300), and assuming that two-thirds of them are found to vary as to value of machinery, and one-third to vary as to space occupied, we get £200 and £100 per week respectively. These amounts will then be apportioned to the different processes according to the value of the machinery used in, or the space occupied by, each process. For example :—

	Value. £		Value Expenses. Pence.	
Pre-roving process	17,000	...	16,320	
Roving process	8,000	...	7,680	
Spinning process	25,000	...	24,000	
Total value	£50,000	...	48,000	= £200

	Space occupied. Sq. yds.		Space Expenses. Pence.	
Pre-roving process	2,750	...	3,300	
Roving process	2,250	...	2,700	
Spinning process	15,000	...	18,000	
Total space	20,000	...	24,000	= £100

TOTAL EXPENSES.

	Value.		Space.		Total.
Pre roving process	16,320	...	3,300	...	19,620
Roving process	7,860	...	2,700	...	10,380
Spinning process	24,000	...	18,000	...	42,000
Total					72,000d. = £300

It is now necessary to express these expenses on the same basis as the productions: as, for instance :—

(a) Pre-roving process ...... 785d. per 100 intermediate spind
(b) Roving process .... 100d. per 100 roving spindles
(c) Spinning process......... 420d. per 1,000 mule spindles

Applying to these amounts the productions of each process in the same way as they have been applied in the case of wages, we get—

(*a*) PRE-ROVING PROCESS:

$\frac{785\text{d.}}{1{,}700\text{ lb.}}$ = 0·462d. per lb. of yarn.

(*b*) ROVING PROCESS:

Roving for 50's $\frac{100\text{d.}}{460\text{ lb.}}$ = 0·217d. per lb. of yarn.

Roving for 60's and 70's $\frac{100\text{d.}}{350\text{ lb.}}$ = 0·286d. per lb. of yarn.

(*c*) SPINNING PROCESS:

50's counts $\frac{420\text{d.}}{450\text{ lb.}}$ = 0·933d. per lb. of yarn.

60's counts $\frac{420\text{d.}}{380\text{ lb.}}$ = 1·105d. per lb. of yarn.

70's counts $\frac{420\text{d.}}{310\text{ lb.}}$ = 1·355d. per lb. of yarn.

Adding together the expenses of the different processes, we get—

	50's.		60's.		70's.
Pre-roving process ...	0·462	...	0·462	...	0·462
Roving process	0·217	...	0·286	...	0·286
Spinning process	0·933	...	1·105	...	1·355
Total expenses ...	1·612d.	...	1·853d.	...	2·103d.

(4) **DISCOUNT ON SALE.**—On yarn sold in the Manchester market discount is at the rate of 2½ per cent., or if sold through an agent 3½ per cent. Discount must be added to the cost of manufacture in order to get the total cost of the yarn, for the spinner does not receive payment at the price at which he sells, but at that price *less* discount. An effort has recently been made by spinners to dispense with this trade discount, and to quote their yarns net; but up to the present a sufficient proportion of the members of the cotton trade are not in favour of the proposal to carry it into practice. As the discount is added to the cost, to be taken off again in the payment, one does not see that the proposal could be anything but beneficial to the trade, and would greatly simplify both yarn costing and ordinary bookkeeping.

Before the cost of discount can be added, the selling price of the yarn must be fixed: for the cost per lb. of discount will vary with the selling price, a higher-priced yarn of even the same count costing more per lb. in dis-

count than a lower-priced yarn. On a yarn price of 16d. per lb. the discount at $2\frac{1}{2}$ per cent. will be 0.4d.; on one at 20d., 0.5d., and so on.

In practice it is helpful to have discount tables prepared for handy reference, shewing the cost in discount at all the different rates under which the spinner trades, for a wide range of prices.

Collecting the various items of cost in the foregoing example, the spinner now ascertains the total cost of the yarn produced:—

Counts	50's		60's		70's
	d.		d.		d.
Cotton	10·975	...	10·975	...	10·975
Wages	1·581	...	1·848	...	2·148
Expenses	1·612	...	1·853	...	2·103
Working cost	14·168	...	14·676	...	15·226
Discount	·375	...	·387	...	·412
Total cost	14·543	...	15·063	...	15·638
Selling price	15·0	...	15·5	...	16·5

In actual practice, in a well-organised concern, the cost of any particular yarn may be ascertained in a few minutes, the productions of all yarns and various items of cost being tabulated in handy form for reference, and being constantly brought up to date. When once the total wages and expenses have been ascertained and apportioned, they remain fixed until a change of conditions makes a new basis necessary. When the spinner desires to quote a price, the only labour involved is the ascertaining of the price of cotton, the extraction from the tables of the four items of cost, and their addition.

PROFIT.—The difference between the cost and the selling price will be profit or loss. In the examples just quoted, the profits would be—

Counts	50's		60's		70's
	d.		d.		d.
Selling price	15	...	15·5	...	16·5
Total cost	14·543	...	15·063	...	15·638
Profit	0·457	...	0·437	...	0·862

It is very desirable, however, that the spinner should have some method of bringing these various amounts of profit to a common basis, so that comparisons may be made as to which is the most profitable yarn. This may be done by expressing them as a return on capital, or by comparing them with a previously ascertained table

shewing the amount of profit required on the different counts to give a certain return, say 5 per cent.

In a concern of 100,000 spindles, having a paid-up capital of £60,000, the amount required to provide a 5 per cent. return would be £3,000 per annum, or $3{,}000 \div 50 = £60$ per week, or $60 \times 240 \div 100 = 144$d. per 1,000 spindles per week.

Dividing this amount by the productions of the various counts, the amount of profit per lb. required to give a 5 per cent. return is—

50's $\frac{144\text{d.}}{450\text{ lb.}} = 0{\cdot}32$d.

60's $\frac{144\text{d.}}{380\text{ lb.}} = 0{\cdot}379$d.

70's $\frac{144\text{d.}}{310\text{ lb.}} = 0{\cdot}465$d.

Comparing these figures with the profits per lb. realised, it will be seen at a glance what return on capital is being given by the various yarns, and therefore which is most profitable.

Another method of comparing the profits is to ascertain the amount of profits per 1,000 spindles, and to compare these profits with the amount per 1,000 spindles required to give a 5 per cent. return. For example—

	50's	60's	70's
Profit realised per lb.	0·457d.	0·437d.	0·862d.
Production per 1,000 spindles	450 lb.	380 lb.	310 lb.
Profit per 1,000 spindles realised ...	206d.	166d.	267d.
Profit per 1,000 spindles required to give 5%	144d.	144d.	144d.

By a periodical examination of the profits of the whole of the yarns produced in this way, the spinner is kept constantly informed which are his most profitable yarns, and which sales it is to his interest to push.

YARNS FOR EXPORT.—The preceding examples are all for yarns intended for sale in the home market upon ordinary "home-trade" terms; but if the spinner carries on in addition to his home trade a foreign trade, in which he quotes prices in a foreign currency for yarns delivered free from export charges to the foreign user, special costing calculations will be required, because of special additional charges that will be incurred.

In most countries there is an import duty upon cotton yarns, which varies according to the counts. This duty the exporting spinner will have to pay to the foreign Customs authorities, compensating himself in

the price at which he sells to his customer. He will also have to pay freight, insurance, and packing charges, all of which he must add to his home trade price before quoting.

In the case of a spinner carrying on both a home and a foreign trade, it is desirable to separate in his account books the duty and all other costs of exporting yarns, from the ordinary working charges incurred in production. If this be not done, and if the foreign charges be included in the working expenses, then there will result errors in the home-trade costing—for expenses which have nothing whatever to do with home-trade yarns will be charged against them. Costing should in such a case be first on the basis of a home-trade yarn, and when this has been done the home-trade price may be taken as the basis for foreign prices. These are then ascertained by adding to the home-trade price the amount of charges to be incurred in the payment of duty, freight, packing, insurance, etc.

To take one case by way of example: A yarn of 50's counts for export to Germany, to be delivered with all charges paid, and to be invoiced in German currency. Terms 2 per cent. discount, payment in 45 days (as against home-trade terms of $2\frac{1}{2}$ per cent. discount, payment in 14 days). The home-trade price as ascertained by home-trade costing is (say) 15d. Then—

(1) **Import Duty.**—The German import duty on yarn of 50's English counts is 22 marks per 100 kilos.; the currency being practically marks 20.50 to the £, and a kilo. being equal to 2.205 lb. weight. Then the duty per lb. in pence is—

$$\frac{22 \times 240}{100 \times 2{\cdot}205 \times 20{\cdot}50} = 1{\cdot}17\text{d.}$$

(2) **Freight.**—This item of expenditure will be paid to a "forwarding agent," who will quote a through rate for yarns from the spinner's place of business to destination. This will include English railway carriage, sea freight, and railway carriage abroad. Suppose, for example, that the rate quoted is 75 marks per 1,000 kilos. gross weight, which will be equal to 860 kilos. net. Then the cost per lb. of yarn in pence will be—

$$\frac{75 \times 240}{860 \times 2{\cdot}205 \times 20{\cdot}50} = 0{\cdot}46\text{d.}$$

(3) **Insurance and Sundry Charges.**—These charges will include marine insurance of the yarn during its

sea voyage, Custom House fees, and other little sundry expenses. The cost will not be a large one; on 50's counts at the price named it will be about 0.05d. per lb.

(4) **Packing Cases.**—In the home trade the yarn would be packed in the spinner's own skips or cases, which would be returned by the manufacturer. In the exporting trade, however, the cost of carriage makes it preferable to pack the yarn in light shipping cases, which become the property of the foreign user. The cost of the cases, therefore, must be added to the cost of the home-trade yarn. If the yarn be shipped in 400 lb. cases, they will cost about 5s. each, which per lb. of yarn will be—

$$\frac{60\text{d.}}{400} = 0{\cdot}15\text{d.}$$

(5) **Credit.**—In the home trade the account for the yarn would be paid in 14 days from the date of invoice. In the case we are now considering, the credit allowed is 45 days, or 31 days in excess of that allowed in the home trade. One thousand lb. of yarn at 17d. (which will be about the price of our yarn when all charges are added), amount to £70 16s. 8d.; and 31 days' credit on this amount would, at 5 per cent. interest, be 6s., or per lb. of yarn—

$$\frac{72\text{d.}}{1{,}000\text{ lb.}} = 0{\cdot}07\text{d.}$$

(6) **Discount.**—The discount allowed in the home trade is $2\frac{1}{2}$ per cent.; in the present case it is 2 per cent. only. Therefore the spinner gains $\frac{1}{2}$ per cent. on the value of the yarn, and this amount must be deducted from the cost. On 17d., $\frac{1}{2}$ per cent. is—

$$\frac{17\text{d.}}{200} = 0{\cdot}08\text{d. per lb.}$$

Collecting now these various items of cost, we get—

Import duty	1.17d.
Freight	0.46
Insurance and sundry charges	0.05
Packing cases	0.15
Credit	0.07
	1.90
Less discount	0.08
Total exporting cost	1.82d.
Home trade price..............................	15d.
Exporting charges	1.82
Foreign price	16.82d. per lb.

Converting this price into German currency of so many marks per kilo., we get—

$$\frac{\overset{\text{d. per lb.}}{16{\cdot}82} \times \overset{\text{lb. per kilo.}}{2{\cdot}205}}{\underset{\text{pence per £}}{240}} \times \overset{\text{marks per £}}{20{\cdot}50} = \overset{\text{marks}}{3{\cdot}17} \text{ per kilo.}$$

By the use of tables and "constant numbers," which will readily suggest themselves in practice, the whole of these calculations may be prepared beforehand, and condensed into one final table of two columns —shewing in one column the English price per lb. on home-trade terms, and in the other column the price in foreign currency, all charges paid.

THE COSTING OF CLOTH

For the ordinary run of cotton goods woven in the grey state, "cost of cloth" is made up of three chief items, namely—materials, wages, and fixed expenses.

MATERIALS comprise—Warp, Weft, and Size.

WAGES include those paid—For the Preparation of Yarn, for Weaving, and for "Datal" Operatives (*i.e.*, operatives paid by time, not by piecework).

FIXED EXPENSES include—Rent, Interest, Commission, Depreciation, Rates, Taxes, Insurance, Coal, Gas, Water, Stores, Repairs, Renewals, and Carriage.

For any given fabric the value of materials and also wages paid for Preparation and Weaving can be calculated with reasonable accuracy; but in the majority of cases it is difficult to apportion the remaining items exactly; and it is on this point that the methods adopted by different manufacturers chiefly vary.

To calculate quantities of warp and weft in any given cloth, it is necessary to know the following particulars, all of which must be actual, not nominal: —

1. Total number of ends or warp threads.
2. Warp length, *i.e.*, taper's or slasher's length.
3. Number of picks per inch.
4. Reed width, *i.e.*, width occupied by the yarn in the reed.
5. Cloth length.
6. Yarn counts.

For costing purposes it is necessary that the Quantities should include allowances for "waste"—*i.e.*, material rendered unusable during the various processes. The amount of waste naturally varies with the class and quality of material, the nature of the processes through which it passes, and the style of the cloth. For the ordinary range of cotton cloth, 40 yards per hank (approximately 5 per cent.) will cover the waste made, thus leaving 800 yards per hank actually to enter the cloth. It may be noted that the 40 yards per hank, or 5 per cent., must cover not only the waste actually returned from the various processes, but also loss by damaged pieces, deficiency in counts, and other drawbacks.

The following formulæ are then applied :—

$$\frac{\text{Total Ends} \times \text{Taper's Length}}{800 \times \text{Counts}} = \begin{array}{l}\text{Weight of Warp Yarn,} \\ \text{including Waste.}\end{array}$$

$$\frac{\text{Picks per Inch} \times \text{Reed Width} \times \text{Cloth Length}}{800 \times \text{Counts}} = \begin{array}{l}\text{Weight of Weft Yarn,} \\ \text{including Waste.}\end{array}$$

The cost of Sizing Materials is usually included in the fixed expenses, but sometimes it is treated separately. In the latter case, the total cost of a mixing is divided by the number of pounds of yarn it will size, and is thereby reduced to a price per lb. It may then appear as a separate item in the cost, or be added on to the yarn price.

Wages for Preparation—*i.e.*, winding, warping, sizing, and drawing-in or twisting—and also for Weaving, are invariably based upon piece-work rates, which are contained in various "Lists" agreed upon by employers and operatives. Such charges for any given cloth can therefore be definitely calculated.

As already stated, the remaining items can be dealt with in different ways. Thus the cost per piece, on account of one or all of them, can be obtained by dividing the total number of pieces produced in a given period into the amount expended during the same period; or they may be apportioned to each loom and divided by the number of pieces which it will turn off. The general method, however, is to compare all the charges with the wages paid for weaving, and reduce them to a percentage

thereof. Since the weaving wage for a given cloth can easily be calculated, it is then only necessary to add the required percentage for expenses. When the ranges of fabrics produced by a given concern do not vary considerably, the method is sufficiently accurate for practical purposes. Further, under similar conditions it will be found that the preparation wages—*i.e.*, winding, warping, drawing-in, etc.—vary only in a slight degree; therefore these also may be included in the percentage of expenses.

The items as well as the amounts will, of course, vary for different mills and different classes of cloth, but for the ordinary run of plain goods it is considered that all expenses, other than the weaving wage, amount on an average to 75 per cent. of the latter—or (as it is termed) expenses are three-quarters of the weaving wage. Thus the cost of a cloth would be one-and-three-quarter weavings, in addition to the cost of warp and weft.

As an example, we may take a standard cloth, known on the market as "36-76, 19 × 22, 32/36." This (stated at length) means that the cloth is 36 inches wide, 76 yards long, and contains 19 "ends" (or warp threads) and 22 "picks" (or weft threads) per quarter inch, while the twist or warp is 32's and the weft 36's—all being actual, not nominal, particulars. Certain allowances for contraction in the warp length and shrinkage in the width must be made, the same varying considerably according to the style of cloth, nature of yarns, and other factors. In this case we assume them to be approximately 6 per cent., which will give the Warp or taper's length to be 76 + 6 per cent. = 80.5 yards, and the Reed width 36 + 6 per cent. = 38.16 inches.

Ends per inch. Inches. Yards.

Weight of Twist $$\frac{76 \times 36 \times 80{\cdot}5}{800 \times 32} = 8{\cdot}6 \text{ lb.}$$

Weight of Weft $$\frac{88 \times 38{\cdot}16 \times 76}{800 \times 36} = 8{\cdot}8 \text{ lb.}$$

To find the Weaving Price.—For Lancashire (England) and district this may be obtained from the "Uniform List of Prices for Weaving," and may be worked out as follows (assuming the cloth to be woven on a 41-inch reed space loom):—

2d. per pick.
22 = picks per $\frac{1}{4}$ in.
——
44 = price per 100 yards.
2.2 = 5 per cent. deduction for width of loom.
——
41.8
76
——
31.76 = price for 76 yards (divided by 100 yards).
1.58 = 5 per cent. on for reed used.
——
33.34
1.33 = 4 per cent. on for picks.
——
34.67 = weaving price.
1.73 = 5 per cent. increase (made in 1912) on List rate of wages.
——
36.40d.

We thus ascertain the Total Cost of the Cloth to be—

	d.
Warp: 8.6 lb. at 10d.	86
Weft: 8.8 lb. at $9\frac{3}{4}$d.	85.8
Weaving wage	36.4
Expenses 75 per cent.	27.3
Total cost per piece	235.5 = 19/$7\frac{1}{2}$

For **coloured** and **fancy** goods the method of costing usually adopted is similar to that explained above for grey goods—except that some of the items there included in the general expenses are treated separately, and (as may be expected) the remainder bear a higher ratio to the weaving wage, owing to the more extensive and complicated nature of the preparatory and other processes.

An example is given below to show the method of dealing with the various items, those for Preparation being taken separately, and the remainder as equal to the Weaving Wage. This method is termed "Double Weaving and Preparation." Prices for fancy cloths are generally quoted per yard, and it is generally more convenient to calculate the total cost of the cloth obtained from a full warp, as the preparation costs can be more easily dealt with.

To find the cost per yard of the following blouse material:—400 yards cloth from 440 yards warp; reed 34 dents per inch, 32 inches wide in the reed, 17 picks per $\frac{1}{4}$ inch, 32's blue and 2/40's white mercerised, checking pattern exactly as warp pattern:—

WARP PATTERN.

36	blue	40's
4	white mercerised	2/40's
36	blue	40's
4	white mercerised	2/40's
12	blue	40's
10	white mercerised	2/40's
12	blue	40's
4	white mercerised	2/40's
118		
18	repeats	
944		
118		
2,124		
24	blue added	
28	white 2/40's selvedge	
2,176		

PRICES.

40's warp, at 1s. 1d. per lb.
2/40's selvedge yarn, 1s. 0½d. per lb.
32's weft yarn, 10d. per lb.
2/40's white mercerised, 2s. 6½d. per lb.
Bleaching 2/40's selvedge, ¾d. per lb.
Dyeing blue warp, 3½d. per lb.
Dyeing blue weft, 2½d. per lb.
Sizing blue warp and selvedge yarn, 7d. per blue.
Winding 40's and selvedge yarn, 1d. for 30 hanks.
Winding weft and mercerising warp, 1d. for 20 hanks.
Warping, 8d. per 1,000 hanks.
Beaming, 1d. per 100 yards.
Drawing-in, 6d. per 1,000 ends.
Weaving, 3d. per pick per ¼ inch for 100 yards cloth.
Expenses, same as weaving.
Finishing, ¼d. per yard.
Allow 40 yards per hank for waste in warp and weft.

SUMMARY.

Ends	blue, 96 × 18 + 24 =	1,752
,,	white, 22 × 18 =	396
,,	selvedge	28
		2,176

(See Table on next page.)

	Hanks	Counts	Weight	Price	Pence
Blue warp ... ... $\frac{1752 \times 440}{800}$ =	963·6	40's	24·09	1/1	313·17
White mercerised warp ... ... $\frac{396 \times 440}{800}$ =	217·8	2/40	10·89	2/6½	332·14
Selvedge ... ... $\frac{28 \times 440}{800}$ =	15·4	2/40	·77	1/0½	9·63
Blue weft ... ... $\frac{68 \times 32 \times 400 \times 96 \text{ picks per pattern}}{800 \times 118 \text{ ,, ,,}}$ =	885·33	32's	27·67	10	276·70
White weft ... ... $\frac{68 \times 32 \times 400 \times 22 \text{ ,, ,,}}{800 \times 118 \text{ ,, ,,}}$ =	202·85	2/40	10·14	2/6½	309·27
Bleaching selvedge yarn...	—	—	·77	¾	·58
Dyeing blue warp	—	—	24·09	3½	84·32
Dyeing blue weft	—	—	27·67	2½	69·18
Winding 40's and selvedge	979·00	—	—	1d. per 30	32·62
Winding weft and mercerised warp...	1305·98	—	—	1d. per 20	65·30
Warping (2176 × 440) ÷ 840	1139·81	—	—	8d. per 1,000	9·12
Sizing blue warp and selvedge	—	—	24·83	7d. per 10 lb	17·38
Beaming, 440 yds.	—	—	—	1d. per 100 yds.	4·4
Drawing-in, 2,176 ends	—	—	—	6d. per 1,000	13·06
Weaving, 400 yds., 17 picks, @ 3d. = 17 × 3 × 4	—	—	—	—	204·00
Expenses as weaving	—	—	—	—	204·00
Finishing, 400 yds.	—	—	—	¼	100·00
Total cost	—	—	—	—	2044·87

Price per yard, 2044·87 ÷ 400 = 5·11—say 5⅛.

☞ The wages of weavers, etc., in Lancashire were advanced in 1912 by five per cent., which amount should be added to the wage items in these prices.

Particulars Required to Find Prices for Weaving in Accordance with the Uniform List. (Lancashire, England),

(As required by Act of Parliament of the United Kingdom).

(1) Width of reed space measured from the fork grate on one side to the back board on the other.

(2) Width of cloth on the counter.

(3) Counts of reed or number of threads per inch, two in a dent or opening, and where there are less or more than two in a dent it should be stated as follows, always giving the number of threads in each dent first—One in a dent, 1/50; three in a dent, 3/58, etc.

(4) Actual picks, or wheel and dividend, or when Pickles' or other similar taking-up motions are used, the number of teeth to a pick, or pick per tooth, should be given in place of dividend; whenever actual pick is given neither wheel nor dividend is necessary; and when using Whittaker's taking-up motion it is best this should be done.

(5) Length of cloth, care being taken to describe the length of stick if different to 36 inches.

(6) When using twist 28's or coarser, or weft below 40's or above 100's, the actual counts should be given, but when using any other counts they may be described as medium.

(7) The piecework price.

To Find the Weight of Twist, Weft and Size, in a Piece of Cloth to Weigh $8\frac{1}{4}$ Pounds.

Given—Cloth 39, Reed 60, wheel 35, yards $37\frac{1}{2}$, twist 32, weft 33, dividend 507.

Rule—First: Multiply the length of yarn required $40\frac{1}{2}$ yards, counts of reed 60, and width in reed 41 inches together for a dividend; multiply the yards in hank (840) by the counts of the twist for a divisor, and the quotient will be the weight of twist.

Thus $\dfrac{40.5 \times 60 \times 41}{840 \times 32} = 3.70$ lb. weight of twist.

Second: Multiply the length of piece ($38\frac{1}{2}$ss. yards) picks in an inch (57.94) and the width the yarns stand in

the reed (41 inches) together for a dividend. Multiply 840, the yards in a hank, by the count of weft, 33, for a divisor. The quotient will be the weight of weft required.

$$\textit{Thus}\ \frac{38\frac{1}{2} \times 57.94 \times 41}{840 \times 33} = 3.29 \text{ lb. weight of weft.}$$

Weight of twist in piece...	3.70 lb.
Weight of weft in piece....	3.29 ,,
Total weight of yarn	6.99 ,,
Weight of size	1.26 ,,
	8.25 ,, weight of piece.

To Find the Net Weight of Twist or Weft.

TWIST.—The figures underneath the respective counts in the following table, if multiplied by the length of yarn and number of ends, placing the decimal point seven figures from the right hand, will give the NET weight of twist in lb. and decimals thereof; thus 32's twist, 40 yards, 2,400 ends—

$$2{,}400 \times 40 \times 372 = 3.5712000, \text{ or } 3 \text{ lb. } 9 \text{ oz.}$$

WEFT.—The same figures, if multiplied by the length of cloth, width in inches and number of picks per inch, placing the decimal point seven figures from the right hand will give the NET weight of weft in lb. and decimals thereof; thus, 40's weft, 40 inches in reed, 40 yards cloth, 60 picks per inch—

$$40 \times 40 \times 60 \times 298 = 2{,}8608000, \text{ or } 2 \text{ lb. } 13\tfrac{3}{4} \text{ oz.}$$

Twist or Weft	10's	11's	12's	13's	14's	15's	16's
	1190	1082	992	916	850	794	744
Twist or Weft	17's	18's	19's	20's	21's	22's	23's
	700	661	627	595	567	541	518
Twist or Weft	24's	25's	26's	27's	28's	29's	30's
	496	476	458	441	425	411	397
Twist or Weft	31's	32's	33's	34's	35's	36's	37's
	384	372	361	350	340	331	322
Twist or Weft	38's	39's	40's	41's	42's	43's	44's
	313	305	298	290	283	277	271
Twist or Weft	45's	46's	47's	48's	49's	50's	51's
	265	259	253	248	243	238	233

Twist or Weft	52's	53's	54's	55's	56's	57's	58's
	229	225	220	216	213	209	205
Twist or Weft	60's	62's	64's	66's	68's	70's	72's
	198	192	186	180	175	170	165
Twist or Weft	74's	76's	78's	80's	82's	84's	86's
	161	157	153	149	145	142	138
Twist or Weft	88's	90's	92's	94's	96's	98's	100's
	135	132	129	127	124	121	119

To Find the Weight of Twist with 1½ Per Cent. Added for Waste.

The figures underneath the respective counts, if multiplied by the length of yarn, and number of ends, placing the decimal point seven figures from the right hand, will give the weight in lb. of twist, with 1½ per cent. added for waste.

Twist	10's	11's	12's	13's	14's	15's	16's
	1208	1098	1007	929	863	806	755
Twist	17's	18's	19's	20's	21's	22's	23's
	711	671	636	604	575	549	525
Twist	24's	25's	26's	27's	28's	29's	30's
	503	483	465	448	432	417	403
Twist	31's	32's	33's	34's	35's	36's	37's
	390	378	366	355	345	336	327
Twist	38's	39's	40's	41's	42's	43's	44's
	318	310	302	295	288	281	275
Twist	45's	46's	47's	48's	49's	50's	51's
	269	263	257	252	247	242	237
Twist	52's	53's	54's	55's	56's	57's	58's
	232	228	224	220	216	212	208
Twist	60's	62's	64's	66's	68's	70's	72's
	201	195	189	183	178	173	168
Twist	74's	76's	78's	80's	82's	84's	86's
	163	159	155	151	147	144	141
Twist	88's	90's	92's	94's	96's	98's	100's
	137	134	131	129	126	123	121

To Find the Weight of Weft, with 4 Per Cent. Added for Waste.

The figures underneath the respective counts in the following table, if multiplied by the length of cloth, width in inches, and number of ends per inch, placing the decimal point seven figures from the right hand, will give the weight in lb. of weft, with 4 per cent. added for waste.

Weft	10's	11's	12's	13's	14's	15's	16's
	1238	1126	1032	952	884	825	774
Weft	17's	18's	19's	20's	21's	22's	23's
	728	688	652	619	590	563	538
Weft	24's	25's	26's	27's	28's	29's	30's
	516	495	476	459	442	427	413
Weft	31's	32's	33's	34's	35's	36's	37's
	399	387	375	364	354	344	335
Weft	38's	39's	40's	41's	42's	43's	44's
	326	317	310	302	295	288	281
Weft	45's	46's	47's	48's	49's	50's	51's
	275	269	263	258	253	248	243
Weft	52's	53's	54's	55's	56's	57's	58's
	238	234	229	225	221	217	213
Weft	60's	62's	64's	66's	68's	70's	72's
	206	200	193	188	182	177	172
Weft	74's	76's	78's	80's	82's	84's	86's
	167	163	159	155	151	147	144
Weft	88's	90's	92's	94's	96's	98's	100's
	141	138	135	132	129	126	124

COSTS OF PRODUCING CLOTHS IN LANCASHIRE FACTORIES.

Although the fabrics selected for the following comparisons are standard makes, the qualities vary considerably, not only in the values of the yarns, but also in the dimensions, reed, pick, and yarn counts. It is very rarely that they are made strictly according to the NOMINAL specifications :—

	Printers.				8¼lb. Shirtings.			
	Nominal.		Actual.		Nominal.		Actual.	
Width and Length	32″/116 L S		32″/116 L S		39″/37½ L S		38½″/37½ L S	
Reed and Pick...	16 x 16		15 x 15		16 x 15		15 x 14	
Yarns	32 T/50 W		36 T/54 W		30T/30W		34 T/34 W	
	lb.	at	Pence		lb.	at	Pence	
Twist	8·88	11⅝	91·88		3·1	11⅝	35·1	
Weft	5·29	12¾	67·44		3·06	10¾	32·9	
					size		3·1	
Waste			4·78		waste		2·04	
Wages: A Weaving			34·12				11·02	
B Preparation ...			8·52				3·67	
C Datal			5·11				1·66	
Interest, Depreciation ...			3·57				1·05	
Rates, Taxes, Insurance ...			·97				·31	
Fuel, Light, Water			1·94				·79	
Stores, Repairs			4·87				2·1	
Carriage			1·3				·79	
Cost at Mill			224·50				94·53	
			18/8½				7/10½	

	Shirtings.				Shirtings.			
	Nominal.		Actual.		Nominal.		Actual.	
Width and Length	38″/38 L S		37½″/38 L S		36″/75 L S		36″/75 L S	
Reed and Pick	18 x 16		17 x 15		19 x 19		18 x 18	
Yarns	30 x 30		34 T/34W		32 T/40 W		32 T/44 W	
	lb.	at	Pence		lb.	at	Pence	
Twist	3·3	11⅝	37·51		7·8	11⅝	88·3	
Weft	3·24	10¾	34·83		5·64	11½	62·04	
	size		3·30		size		7·8	
Waste	waste		2·16		waste		4·5	
Wages: A Weaving			12·41				29·22	
B Preparation ...			4·16				7·60	
C Datal			1·86				4·38	
Interest, Depreciation ...			1·19				3·06	
Rates, Taxes, Insurance ...			·36				·84	
Fuel, Light, Water			·89				1·68	
Stores, Repairs			2·37				5·57	
Carriage			·89				1·4	
Cost at Mill			101·93				216·39	
			8/6				18/0½	

When cloth is sold to an agent, add 1½ per cent. to above mill costs. LS = 36½ inches to the yard, *i.e.*, "Long Stick." Salaries of managers included in Datal Wages. Office expenses included in Stores, Repairs, etc.

1. COTTON REQUIREMENTS BOOK.

1915		lb. Yarn Sold	lb. Cotton Required	1915	lb. Cotton Bought	Cotton Position 1915	Over Bought	Under Bought
Jany.	5	22 000	24,860	Jany 7	26 000	Jany 7	1140	-

2. COTTON BOUGHT BOOK.

1915		No. of Bales	Weight	Mark	Variety	Price	Mixing	Seller	Terms	Shipment or Delivery
Jan	14	50	36,000	XYZ	Egyptian	d 10½	5	J Brown & Co	C I F	Jan.
"	20	100	72,000	ABC	do	d 9¼	6	do	C I F	Feb.

3. COTTON FUTURES BOOK.

Bought 1915	Bales	Variety	Shipment	Price	Sold 1915	Bales	Variety	Shipment	Price
Jan 20	100	American	June/July	d 9	Feb. 27	100	American	June/July	d 8 31
Feb. 8	200	do	Aug/Sept	d 8 30					

4. COTTON RECEIPT BOOK.

1915		Mark	Bales	Bale Numbers	Gross Weight lb.	No. of Bands	Net Weight lb.	Total Weight
Jany	8	TPO	4	1	720	11	698	
				2	713	11	691	
				3	720	11	698	
				4	693	11	671	2758

5. COTTON MIXING BOOK.

1915		Mixing	Mark	Bale Number	Date Received	Total Bales in Mixing
Jan.	20	5	TPO	2	Jan 8	
				220	do	
				59	do	
				73	Decr. 3	
				82	Jan. 7	
				8	do	
				7	do	
				34	Nov. 16	
			XYZ	2	Aug. 4	
				6	Nov. 20	
				27	Sep. 8.	11

DEPARTMENTAL BOOKS FOR A SPINNING MILL

It is impossible to devote too much care to the proper organisation of the Departmental Books of a Spinning Mill. The accountancy books vary very little in the different manufacturing industries; and, further, they are under the general supervision of the firm's auditor, who will advise as to any improvements he may think necessary. But the departmental books deal largely with the technical aspect of the trade. They do not come within the survey of the auditor, and there is not, therefore, anything like the same uniformity of system as in the account books. It is apparent, however, to anyone actively engaged in the technical departments, that unless proper records are kept in those departments the business will not move with the smooth regularity that is essential. Not all the departmental books will be kept in the mill. Some are more conveniently kept in the office, and some in the warehouse; but all should fit together to make a complete record of the whole technical working of the concern, so that any particulars required for any purpose can be quickly and accurately ascertained. The following specimen rulings and entries are suggested as the nucleus of a system which will cover all that is required:—

The books fall into five groups, dealing with—I., Cotton. II., Card Room. III., Spinning Room. IV., Yarn Warehouse. V., Mill Stores.

I. **Cotton.**—The Cotton Requirements Book (No. 1) shews the position of cotton purchased in relation to yarn sold, from week to week, or from day to day, indicating whether cotton is over or under bought.

The Cotton Bought Book (No. 2) is a record of the various purchases of actual cotton, with price and delivery, and also the mixing for which they are to be used.

The Cotton Futures Book (No. 3) records the transactions in futures, and shews at a glance what contracts are still open.

The Cotton Receipt Book (No. 4) shews the full particulars of every bale received.

The Cotton Mixing Book (No. 5) records the final disposition of the bale, and provides a reference as to the marks of cotton used in the making of the different yarns.

6. COTTON BALE STOCK BOOK.

1915			TPO	OT	POT	ROC								Total.
Jan	5	Received	50	10										60
"	6	Mixed	10	5										15
"	7	Stock	40	5										45
"	10	Received	20	10	50	100								180
			60	15	50	100								225
"	13	Mixed	20	10	30	10								70
"	14	Stock	40	5	20	90								155

7. COTTON SAMPLE BOOK.

1915	Mark	Loss to Scutcher	Loss to Card	Loss to Comber	Yarn Counts	Strength per Lea
Jan 20	ox	5%	12%	22%	60 T	34 lb
" 27	xyz	4·7%	13·2%	21%	80 T	27 lb

8. CARD WIRE BOOK.

No of Card	Cylinder Covered	Doffer Covered	Flats Covered
1	July 12. 1910	July 12 1910	May 13. 1908
2	Mar. 5. 1912	Mar. 5. 1912	May 13. 1908

9. DRAW FRAME WRAP BOOK.

1915		No. of Frame	Wrapping				Average	Change Finer	Change Coarser	Remarks
Jan.	5	1	3·8	3·12	3·10	3·6	3·9			Irregular.

10. FLY FRAME WRAP BOOK.

1915		No. of Frame	Hank Roving	Wrappings				Average	Change		Remarks
									Finer	Coarser	
Jan.	5	1	10	4·4	4·2	4·5	4·3	4·3½			

11. FLY FRAME HANK BOOK.

Frame No.	Week ending January 5, 1915			Week ending January 12, 1915		
	Counts	Indicator	Hanks	Counts	Indicator	Hanks
1	10	235	34	10	270	35
2	10	739	35	10	775	36

12. CARDER'S DAY WAGE BOOK.

Pay No.	Name	Occupation	Hours	Rate	Wage			Insurance	Deduction	Net		
1	Brown, James	Stripper & Grinder	55½	30/	1	10	·	7	4	1	9	8
2	Jones, Alice	Card Tenter	55½	12/		12	·	6	3		11	9

13. CARDER'S PIECE WAGE BOOK.

Pay No.	Name	Occupation	Hanks	Counts	Twist Wheel	Price	Wage			Insurance	Deduction	Net		
101	Johnson, Alice	Roving Tenter	70	10	32	3 75	1	1	10	6	3	1	1	7
102	Morgan, June	do	71	10	32	3 75	1	2	2	6	3	1	1	11

Mule Nos: 1 & 2

14. OVERLOOKER'S CHANGE BOOK.

1915	Counts	Hank Roving	Rim Pulley	Tin Roller Pulley	Shaper Wheel	Gain Wheel	Draft Pinion	Drawing Out Wheel	Twist Wheel
Jan. 20	60 T	11	16"	11	40	18/74	46	30/38	84

15. OVERLOOKER'S DAY WAGE BOOK.

Pay No.	Name	Occupation	Hours	Rate	Wage			Insurance	Deduction	Net		
150	Hamer John	Strap Piecer	55½	22/-	1	2		7	4	1	1	8
151	Halton Andrew	Bobbin Carrier	55½	22/-	1	2		7	4	1	1	8

16. SPINNERS' PRODUCTION BOOK.

Week ending Jun 20th 1915

No. of Mules	Counts	lb. Production	Stoppages	Equals Production Full Week
1 & 2	60 Twist	800	nil	800
3 & 4	60 Weft	900	5½ hrs	999

17. SPINNERS' SETT BOOK.

Mule Nos 1 & 2

1915		Counts	Weight lb.	oz.	No. of Mule
Jan	7	60 Twist	102	8	1
"	8	do	101	8	2

18. YARN WRAPPING BOOK.

Mule Nos. 1 & 2

1915	Counts	Wrappings				Average	Change Finer	Change Coarser	Remarks
Jan 5	60T	61	61½	60½	61	61			
" 6		63	59½	64	58½	61			Irregular.

19. YARN TESTING BOOK.

Mule Nos. 1 & 2

1915	Counts	Strength per Lea				Average	Remarks
Jan 5	60 T	30	31	30	32	30¾	
" 6	do	28	29	28	29	28½	Weak.

The Cotton Bale Stock Book (No. 6) may be amplified so as to shew separately the bales in stock in the different storehouses or railway stations. It records weekly the position of all unopened bales.

The Cotton Sample Book (No. 7) contains the particulars of small samples of cotton put through the mill for the purpose of testing for waste and quality.

II. **Card Room.**—In the Card Wire Book (No. 8) are recorded the dates on which the various organs of the carding engines were last covered with wire, thus indicating whether the life of the wire has been sufficiently long or not.

In the Draw Frame and Fly Frame Wrap Books (Nos. 9 and 10) are entered the daily wrappings of the frames, shewing the amount of variation in the sliver. The wrappings are for 2 yards of draw frame sliver and 30 yards of roving sliver.

The Fly Frame Hank Book (No. 11) shews the productions of the various frames for comparative purposes, and also provides the basis for frame tenters' wages.

Nos. 12 and 13 record the whole of the wages, datal and piece-work, in the Card Room.

III. **Spinning Room.**—The Overlooker's Change Book (No. 14) contains entries of the change-wheels on each mule, and the counts spinning. When any alteration in these is made the record is entered, so that the book provides a basis for all change-wheel calculations made by the overlooker. In changing to counts that have been previously spun, the book shews at a glance the wheels required, without further calculation.

The Overlooker's Day Wage Book (No. 15) records the wages of the few datal hands in the spinning room, such as the bobbin carrier, labourer, etc.

IV. **Yarn Warehouse.**—Most of the important yarn particulars books come under the heading of this department, and much of the statistical work of which they form the basis will be worked out in the warehouse. It is essential, therefore, that they should be kept by someone fully alive to the importance of clear and accurate entries.

The Spinners' Production Book (No. 16), with a page for each week, records the mule productions; and, where stoppages have occurred, the calculated productions for a full week. These figures afford a basis of comparison

20. YARN SAMPLE BOOK.

1915		Name	Address	No. of Cops	Counts	Quality
Jan.	4	J. Brown & Co.	New Mill, Darwen.	4	50 T	Carded
"	6	White Mill Co. Ltd.	Halton Rd. Blackburn.	2	70 T	Combed

21. YARN ORDER BOOK.

J. Brown & Co. New Mill, Darwen

1915		Order Number	Weight	Counts	Price	Terms	Deliveries	
							Date	Lb.
Jan	4	20	10,000 lbs	50 T	14	2½ 2 14 days	Jan 6	600
							" 8	1200
							" 10	1783

22. YARN FORWARDING BOOK.

1915		Name	Address		Weight		
					Gross	Tare	Net
Jan.	6	J. Brown & Co.	New Mill, Darwen	2 Skips. 50 T	348	46	302
					346	48	298
					694	94	600

23. EMPTY SKIP BOOK.

Skip No.	Sent Out	Firm	Returned	Sent Out	Firm	Returned	Sent Out	Firm	Returned	Sent Out	Firm	Returned
1	8/1/15	J. Brown & Co.	3/3/15	10/3/15	Roy Mill Co.							
2	10/1/15	J. Marsden	3/4/15									
3	15/1/15	do										

24. YARN STOCK BOOK.

50 Twist					60 Twist				60 Weft			
1915			Skips	Net Weight	1915		Skips	Net Weight	1915		Skips	Net Weight
Jan.	6	Packed	5	1520	Jan. 8	Packed	3	932	Jan. 20	Packed	2	621
"	8	"	3	915								
			8	2435								
"	12	Delivered	3	922								
			5	1513								

between one pair of mules and another, and between one week and another.

The Spinners' Sett Book (No. 17) shews the weight of each sett of yarn as it is weighed in the warehouse for the purpose of the spinner's wage. From this book also are obtained the figures of production for No. 16.

The Yarn Wrapping Book (No. 18), with a page for each pair of mules, contains the wrappings of each sett of cops, and shews any variation in the counts. On the records of this book are based the instructions to the overlooker to change finer or coarser, as the circumstances may require.

The Yarn Testing Book (No. 19) contains similar records regarding the strength of the yarn.

The Yarn Sample Book (No. 20) shews the particulars of sample cops posted to actual or prospective customers.

The Yarn Order Book (No. 21), with a page for each customer, contains the orders booked and the deliveries made against them, thus shewing at a glance the yarn on order for each customer. An alternative ruling for this book is one in which each delivery is deducted from the original weight on order, and a new total on order is recorded with each delivery. This dispenses with the addition of the deliveries as required in No. 21, each time the weight on order is required. The particulars of delivery and declarations may be entered in this book; but if a very varied trade is being carried on, it is desirable to use a separate book, having a page for each customer.

The Yarn Forwarding Book (No. 22) contains the daily record of all yarn sent away, and provides the particulars for invoicing and for the office entries.

The Empty Skip Book (No. 23) is for the purpose of tracing empty skips. Opposite each skip number are the records of its journeys to and from the mill to the customer. Any skip not returned within a reasonable time is easily noticed, and inquiries may then be made as to its whereabouts. This book is entered daily from the Yarn Forwarding Book (No. 22), and from the railway delivery notes of skips returned.

The Yarn Stock Book (No. 24) records the yarn packed and put away into stock. One column is reserved for each count and quality, and the entries are made from the packers' tickets and from the Yarn Forwarding Book (No. 22).

25. WAREHOUSE STORES ORDER BOOK.

Jan 8/15	Order Note Jan 8 1915
	Please Order
5 Bags tubes	5 Bags tubes
1 Roll 4" Belting	1 Roll 4" Belting
1 Cask Tallow	1 Cask Tallow
4 Barrels Engine Oil	4 Barrels Engine Oil
S J Manager.	S J Manager

26. STORES ORDER BOOK.

Jan 8/15	Order Note January 8 1915
J. Hall & Co.	Please deliver
1 Roll 4" Belting	1 Roll 4" Belting.
J B Secretary	J. Brown. Secretary
	N B.—A delivery note must be sent with each delivery.

27. STORES RECEIVED BOOK.

1915	Received from	Goods	Net Weight.
Jan. 8	J. Brown & Co.	2" Strapping	220 lb.
" 10	J. Hilton	5 Bags blue tubes	250 lb.

28. STORES STOCK BOOK.

Mill Brooms

1915		Number
Jan 5	Received from A Jones & Co.	144
" 8	Delivered Spinning Room	12
		132

V. **Mill Stores.**—Although the Stores Books do not relate to any process of manufacture, they are nevertheless worthy of detailed attention; for, with a proper system of recording the ordering, receipt, and distribution of stores, much waste, overlapping, and error are avoided.

The firm's requirements in stores are usually submitted to the manager by the warehouseman, or by the heads of the various departments. After examination, they are then passed on to the office for an official order note. The two order books required for this routine are shewn in Nos. 25 and 26.

On the arrival of the goods they are recorded in a Stores Received Book (No. 27), in which every item should be entered, together with details of size, weight, etc. From this book the incoming bills may be checked.

For the more important and more expensive stores, it is desirable to keep a Stores Stock Book (No. 28), with a separate page for each article, shewing particulars of receipt, distribution, and stock. This system of stores stocks, however, should not be carried too far, or the advantage obtained will not be worth the labour involved. A reliable warehouseman and a good storeroom are all that are required for the smaller stores.

DEPARTMENTAL BOOKS FOR A WEAVING MILL

Generally speaking, bookkeeping in a weaving mill divides itself into two main sections: namely, (1) "External," or that which deals with accounts and secretarial work; and (2) "Internal," or that which deals with the work of the various departments of the establishments. In the first case the system adopted and the books required do not differ materially from those of any ordinary manufacturing establishment; but for obvious reasons both system and books required in the second case vary considerably in different mills, according to their particular circumstances and class of trade. As a rule, however, the "Internal" section is required to deal with—

(*a*) Recording the nature and amount of work accomplished and in progress in the various departments;
(*b*) Enabling departmental and total costs to be accurately determined; and
(*c*) Recording stocks, consumption, and deliveries, of materials and finished goods.

1.—YARN REQUIREMENTS BOOK.

REQUIREMENTS								BOUGHT OR APPROPRIATED.						
				WEIGHT PER PIECE		TOTAL								
DATE	ORDER	QUAL.	PIECES	TWIST	WEFT	TWIST	WEFT	DATE	SPINNER.	WEIGHT	COUNTS.	PRICE.	CONTRACT	FOLIO
March 5	4812	765	1000	5·72	4·86	5720	4860	Mar. 7·	Park Spg Co	6000	32 A T	10½	672	92
								" 8·	Barnes & Co	4860	36 X W	10¼	514	75

2.—YARN CONTRACT BOOK.

DATE	CONTRACT Nº	SPINNER	WEIGHT	COUNTS	QUALITY	PRICE	DELIVERY.	APPROPRIATION. ORDER	APPROPRIATION. LBS	DECLARED DATE	DECLARED	DELIVERIES. DATE	DELIVERIES. SKIPS	DELIVERIES. CTS	DELIVERIES. LBS
92															
March 7	672	Park Spg Co	6000	32	A Twist	10½	as reqd.	4812	5720	Mch 21	8 Skips	Apl 1	3	32	875
												3	2	"	562
75															
Jany 14	514	Barnes & Co	30000	36	X Weft	10	10 skps	3621	7924			Jan 28	10	34	2876
							per week	3680	10962			Jan 31	4	"	1128
							"	4812	4860			Feb 10	9	"	2602

3.—SKIP BOOK.

DATE	SPINNER	CARRIER	SKIP Nº	COUNTS	MARK	INVOICED G	INVOICED T	INVOICED N	DATE RECEIVED	OUR WEIGHT G.	OUR WEIGHT T.	OUR WEIGHT N.	TESTS COUNTS	TESTS STRENGTH	WHERE SENT	EMPTY RETURNED	REMARKS.
April 2	Park Spg Co	L & Y R Co	262	32	AT												
	"	"	402	"	"												
	"	"	27	"	"												

For these purposes the requisite books may be divided into four sections: namely—

(I.) Yarns.
(II.) The Preparation Department.
(III.) The Cloth Warehouse.
(IV.) Stores.

A complete system and set of such books, such as would be required in a mill producing the ordinary run of cotton fabrics, is outlined in the following pages. In the majority of cases the form of the books, together with the specimen entries, will be self-explanatory.

I. **YARNS.**—The objects of this series of books are to secure—

(*a*) The provision of a prompt and sufficient supply of yarns for the cloth orders received;
(*b*) A proper examination of yarns delivered as regards quantity and quality; and
(*c*) Efficient stock-keeping.

In Book No. 1, entry is made of the particular requirements of each order for cloth as it is received, and of purchases or appropriations against the same.

No. 2 shews two pages of the Yarn Contract Book, in which particulars of the contracts made with spinners and deliveries against the same are entered. Two pages of this book are shewn. In the first (page 92) is shewn the method adopted when a special contract is placed for each separate order of cloth. In the second (page 75) the method when a bulk order for a standard yarn is placed, and the requirements of various orders, are appropriated therefrom.

No. 3 shews the Skip Book, in which particulars of yarn deliveries are entered. The entries shewn are made in the office, and the book is then sent to the yarn warehouseman, who upon receipt of the goods enters the date of receipt and the actual weights of the several skips or packages. The book is then returned to the office for comparison of the actual weights with those invoiced by the spinner. Provision is also made for record of count and strength tests, for delivery to bleacher or dyer when necessary, and for return of empties.

No. 4 shews a convenient form of Testing Book.

Nos. 5 and 6 shew two forms of Yarn Stock Books. In No. 5 the yarns are grouped under the name of the spinner, and in No. 6 they are arranged in rotation of

4.—YARN TESTING BOOK.

DATE	SPINNER	CTS.	QUALITY	SKIP	COUNTS						AVG	STRENGTH lbs. per lea						AVG	MOISTURE Regain				REMARKS.
April 4	Park	32	A T	262	31	32	32	31			31½	42	45	46	44			44¼	10	9	9	9	

5.—YARN STOCK BOOK.

SPINNER.		Pearl				Diamond		Park	
COUNTS.		36	40	50	50	24	30	28	
QUALITY.		A	E	EX	EXX	A T	AW	AW	"
SIZE.		2	2	1	1½	2	1½	1½	
March 7	STOCK.	5	6	7	8	2	3	9	
	RECEIVED.	2		1			2		
	USED.	4	2	1	1	2	0	4	
March 14	STOCK.	3	4	7	7	0	5	5	
	RECEIVED.								
	USED.								
March 21									

6.—YARN STOCK BOOK.

COUNTS	March 7. 1913				March 14				March 21	
	STOCK	REC.V.D	TOTAL	USED	STOCK	REC.V.D	TOTAL	USED	STOCK	REC.V.D
32^{X}	5	5	10	4	6					
36^{C}	2	·	2	·	2					
38^{XX}	4	1	5	1	4					
40^{T}	4	2	6	4	2					
44^{E}	3		3		3					
46^{A}	2		2		2					
50^{E}	5	4	9	6	3					

PARTICULARS OF ORDERS.

7.

DATE.	ORDER No.	INCHES.	YARDS.	REED.	SORT.	PATTERN No.	BEAMS.	ENDS.	LENGTH.	TWIST.	DATE TO BE WARPED	WARPER.	CUTS WARPED	ACTUAL WEIGHT.	CAL. WEIGHT.	SIZER.	CUTS SIZED.	MARK.	WHEELS.	PROG. No.	LOOM PINION.	WEFT.	HEADING.	WEAVING PRICE.	
May 3	264	32	60	18/18	72 B	4	6	364	15750	34A	Jue 16				1204			63·0	30/107		48	40 B	5X	1/8	

8.

ORDER. 721 NAME John Wilson & Co

DATE	PIECES	WIDTH	LENGTH	REED	PICK	TWIST	WEFT	WEIGHT	PRICE	DELIVERY
Oct 3	800	36	90	18	18	34	36	18¼	21/1	Dec

WARPED.

DATE	BEAMS	ENDS	CUTS	CUTS TO RUN
Oct 20	6	408	396	404

MILL PARTICULARS

ENDS.	2448
REED.	64
LOOM PINION.	30
SIZED WEIGHT.	10¾ #
MARK.	95·16
TIN-ROLLER.	40
STUD	106
WEIGHT, TWIST PER CWT.	8·15
" WEFT " "	7·9
" SIZE " "	2·20

WEIGHT OF TWIST REQUIRED 6520

" " WEFT " 6320

WEAVING PRICE 2/6½

COUNTS OF TWIST 34

" " WEFT 36

SIZED

DATE	CUTS	CUTS TO SIZE
Oct. 24	396	404

DELIVERIES.

DATE	PIECES	TO DELIVER.	
Nov. 2	100	700	
10	200	500	

9.

WINDER'S BOOK

No. 2

DATE	COUNTS	MARK	WEIGHT	@	L	S	D
Jan 16	36s	A	40 lb	6½		1	1

10.

WARPER'S BOOK

WARPERS No. 4 Mary Mason

DATE	ORDER	BEAMS	COUNTS	ENDS	YARDS	HANKS	SORT	@	L	S	D
Jan 16	72	6	40	402	10750	77		2		12	10

11

SIZER'S BOOK

DATE Jan 21 · 1912

ORDER No. 721
FIRST PROG. No. 417
SORT. 72 CC
ENDS. 2448
REED. 64
WIDTH. 36
LENGTH. 80
WEIGHT. 18¼
MARK. 95/16
TIN ROLLER WHEEL 40
STUD WHEEL. 106
TWIST. 34
WEFT. 36
WHEEL. 36
WEAVING PRICE. 2/5½

PRO.	CUTS	GROSS	TARE	NETT.	REMARKS
417	13	144	53	91	
418	12	137	54	83	Ends out
419	13	145	52	93	Splash
420	13	144	53	91	Cut out

TWADDLE OF SIZE 16

PARTICULARS OF BEAMS

WARPER	ENDS	GROSS	TARE	NETT
4	408	280	65	215
4	408	278	63	215
4	408	281	62	219
3	408	280	65	215
3	408	281	63	218
3	408	281	64	217

counts. In both cases the yarn man should enter the skips as he receives them and affix a label to each; then when a skip is taken from stock the label should be detached and retained by the yarn man, who is thereby enabled to declare his position instantly, and to make up his weekly stock list. The latter, however, should be checked by actual inspection at suitable intervals.

II. **PREPARATION DEPARTMENT.**—The books in this section are designed to record (*a*) the details and progress towards completion of the various orders for cloth, and (*b*) the amount of work performed by the various operatives, who in this department (as in weaving) are usually paid by piece-work rates.

No. 7 outlines a "Particulars" Book. The entries shewn are made in the general office, and the remaining columns are filled in by the foreman as the work progresses.

No. 8 is another form of "particulars" book, in which there is a page or portion of a page for each order.

No. 9 shews a Winders' Book, and No. 10 a Warpers' Book. The ruling of these is varied according to the system of payment adopted. In the examples given the winding is at the rate of 6½d. per score lb., and the warping at the rate of 2d. per hank of 840 yards.

No. 11 shews a Sizer's Book, in which there is a page or part of a page for each set of beams. The particulars in the first column are entered by the foreman from his Particulars Book. The sizer enters the particulars of the back beams as received from the warping room, and of the loom beams as they are produced. He also makes out the "weavers' particulars," of which two forms are given, namely, No. 12 and No. 13. The former also serves as a weavers' tally: that is, for entry of the cuts or pieces as the latter are delivered in the warehouse. In the second case a separate tally, No. 14, is required, which is arranged to shew at a glance how many cuts have been woven and how many are still left on the beam. In both cases a separate piece, which can be detached at the perforation, is provided for the twister or drawer-in as a voucher for his work.

III. **CLOTH WAREHOUSE.**—The chief books in this department are: (1) The Weavers' and Overlookers' Wage Book. (2) Stock Book. (3) Beam Book. And (4) First Cut Book.

12. WEAVER'S PARTICULARS. **13.**

12.

367 LOOM
314 PATT
3862 O/Nº
IN LOOM 12/4/13 | TAPED 9·4·13
16 1 | 2 TAPER'S Nº
21 1 | 1829 PROG.
26 1 | 2 Brocade SORT
10 CUTS
80 YARDS
29 INCHES
33 WHEEL
2 MARKS
4C HEADING
36 E WEFT
3060 ENDS
Medium COUNTS
WARPERS Nº | DIVIDEND
4/6 PRICE

2 TAPER'S Nº
1829 PROG.
2 Bro SORT.
3060 ENDS.
29 INCHES

13.

PROG. Nº 1829. LOOM Nº 72

SATEEN.

ORDER Nº 726 C	WEFT 40 E	HEADING —
REED 96	SLASHER'S Nº 3	No 19
INCHES 30½	CUTS 11	
YDS. OF 90 INS. 36	MARKS IN PIECE 2	
WHEELS 20 DIV. 609	BEAM Nº 1124	
TWIST 36 PRICE 3/9	TWISTER 3 DRAWER	
WIDTH OF LOOM 40	SHAFTS 5	

PROG. Nº 1829

SATEEN.

TWIST 36
REED 96 WIDTH 30½
ENDS 3096
SLASHER'S Nº 3
BEAM Nº 1124
TWISTER'S Nº 3
DRAWER'S Nº
SHAFTS 5

14.—WEAVER'S TALLY.

ORDER.	SORT	CUTS	TWIST	WEFT.	14	13	12	11 (1)	10 (1)	9 (2)	8 (2)	7 (3)	6 (4)	5 (4)	4	3	2	1
726c	Sateen	11	36	40E				1	2	3	4	5	6	7				

Date Jan. 6th. **15.**—WEAVERS AND OVERLOOKERS' WAGE BOOKS.

LOOM	PROG.	SORT	CUTS ON BEAM	TWIST	WEFT	PRICE	THUR	FRI.	SAT	MON.	TUES	WED.	TOTAL	76A	88	C	M	42B				S	D	FINES	L	S	D
														5½	6	7	8	10									
96	21	76A	10	36	36	5½	//	///	/	///	/		10	10								4	7			4	7
97	98	88	12	32	40	6			/	//	///	//	8		8							4	0			4	0
98	467	C	6	40	44	7	/	//	//	/			6			6						3	6			3	6
99	102	M	11	30	30	8				//	///	///	8				8					5	4			5	4
100	104	M	11	30	30	8				/	//	///	6				6					4	0			4	0
101	97	88	12	32	40	6			/	//	///	//	8		6							4	0			4	0
102	105	M	10	30	30	8			/	///	//	///	9				9					6	0			6	0
103	82	42B	8	24	26	10		//	//	//	//		8					8				6	8			6	8
														10	14	6	23	8							1	18	1

18.—PIECE STOCK BOOK.

	76A	88	C	M	42B	5X						
Jan. 6 Act. Stock	10	12	12		15	9						
Woven	10	14	6	23	8	29						
Delivered	10	10	6	23	23	27						
Balance	10	16	12	0	0	1						
Jan. 13 Act Stock	10	17	12	0	0	0						1 Short 5X 1 over 88

Date Jan. 6th.

16.

SORT	M	RX	726	XX	182	PLAIN.	DOBBY.	JACQUARD.
INCHES	38	43	30	36	28			
YARDS	38	90	80	40	60			
REED	56	76	64	80	96			
PICK	13	23	16	20	24			
PRICE	8	3/9	2/1	2/6	4/-			
LOOM No. 196	8					5 4		
197		2						7 6
198			3					6 3
199	9					6 8		
200				3			7 6	
201					1		4 0	

17.

LOOM No. 132

DATE	QUAL.	INCHES	YARDS	REED	PICK	WEFT	HEADING	CUTS ON BEAM	THUR.	FRI.	SAT.	MON.	TUES.	WED	TOTAL	PRICE	S	D	DEDUCTIONS
Jan. 6	A	30	90	60	18	18	5X	10			/			/	2	3/-	6	0	
" 13	.	.	.	.	.	.	.	.				/		/	2	3/-	6	0	
" 20	.	.	.	.	.	.	.	.			/		/		2	3/-	6	0	
" 27	.	.	.	.	.	.	.	.		/					1	3/-	3	0	
Feb 3	72	31	80	72	20	20	6B	12			/			/	2	2/6	5	0	
" 10																			

LOOM No. 133

DATE	QUAL	INCHES	YARDS	REED	PICK	WEFT.	HEADING	CUTS ON BEAM.	THUR	FRI.	SAT.	MON.	TUE.	WED.	TOTAL	PRICE	S	D	DEDUCTIONS
Jan 6	M	40	42	72	14	12	C	8					/	/	2	1/4½	2	8½	
" 13	.	.	.	.	.	.	.		/		/	/		/	4	.	5	6	
" 20																			
" 27	5X	37	60	72	16	14	5X	9	/	/			/		2 / 1	2/8	2 / 2	8½ / 8	
Feb 3	.	.	.	.	.	.	.	.			/		/		2	.	5	6	
" 10																			

In (1) are entered the production and earnings of the separate looms, and also the overlooker's or tackler's wages when these are paid on the poundage basis. Three forms of this book are shewn, namely :—

No. 15, which is a book used in a plain weaving mill where there is only one rate of poundage for tackling. It also provides for the entry of the separate cuts as they are brought in by the weavers, and for the summarising of the weekly production so that stocks and wage totals can be checked.

No. 16 is used when plains and fancies, at different poundage rates, are produced. The looms are grouped according to the tacklers' sets, and the loom productions are copied from the weavers' tallies, which are collected for that purpose on making-up days.

In No. 17 there is a separate page or half-page for each loom, and 52 weeks on a page. This enables a ready comparison to be made of successive weeks' earnings, but it is obviously less convenient for the other purposes mentioned.

No. 18 shews a form of Piece Stock Book, the purpose and use of which will be obvious from the specimen entries given.

It is sometimes a part of the cutlooker's duties to keep account of the position of cloth orders. For this purpose the Cutlooker's Beam Books (Nos. 19 and 20) are useful. On receiving a new beam, the weaver takes the ticket (No. 12 or No. 13) to the cutlooker, who enters in No. 19 (which has a separate page for each order) the particulars recorded. The progressive numbers here entered are compared with the Sizer's Book (No. 11), so that no beams may be overlooked. In No. 20 the particulars of each order are entered at the head of the columns, and underneath the loom numbers on which they are being woven, together with the number of cuts on each beam. The actual quantity woven at any time can then be determined with the assistance of the weaver's tally (No. 14).

It is always advisable to examine carefully the first cut from a new beam, with regard to its length, weight, and other particulars useful for comparison with the quotation or estimated particulars. For this purpose the "First Cut Book" (No. 21) is useful. The purposes and sources of the several items are fairly obvious from their nature.

CUTLOOKER'S BEAM BOOK.

19.

DATE	LOOM	PROG.	SORT	HEADING	TWISTER.
Feb 16.12	721	432	Sateen	No 19	No 4
" 17	69	433	"	"	No 3

20.

ORDER Nº	726 C	854		
PIECES	250 pcs	100		
WIDTH & LENGTH	30½ · 90	30" · 30		
REED & PICK	26 x 30	24 x 24		
TWIST & WEFT	36 x 40	60 x 60		
PINION	20	30		
HEADING	No 19	Blue		
WEAVING PRICE.	3/9	1/2¼		

LOOM	CUTS	LOOM	CUTS	LOOM	CUTS	LOOM
726	11	54	24			
504	11	82	24			
		105	23			

21.—FIRST CUT BOOK.

BEAMS

WARPER	ENDS	GROSS	TARE	NETT.
3	448	290	70	220
7	448	290	69	221
3	448	290	70	220
4	448	287	68	219
3	448	288	68	220

ORDER 1857 SORT 72 B

INCHES 38 YARDS 80 WEIGHT 15½ lb REED 56 PICKS 14

DATE	PROG	NETT Wt OF SIZED YARN	Nº OF CUTS	Wt OF SIZD WARP PER CUT	LOOM Nº	ACTUAL WIDTH	ACTUAL LENGTH	ACTUAL WEIGHT	Wgt OF WEFT USED	LOSS OF SIZE	TWISTER	REMARKS.
3·3·12	417	144	12	12·0	436	38¼	79·24	18½	7·2	10 oz		
4·3·12	418	141	12	11·12	987	38	79·18	18¼	7·4	12 oz		
4·3·12	419	128½	11	11·10	820	38	79·20	18¼	7·4	10 oz		

STORES DEPARTMENT.

22.—DELIVERY BOOK.

OVERLOOKER	DATE	PICKING BANDS	PICKERS	SHUTTLES	SHUTTLE TONGUES	SPINDLES	SWELLS	PICKING PEGS	WEFT FORKS	BRUSHES	EMERY	LACES	OIL	ROPES	BUFFERS	BUFFER STRAPS	CHECK ENDS	STRAPPING LBS	REMARKS
1. J.G.	Sept 2	7	4				1	1	2	1	2	6							
	9	8				2			2	2	3			2					
	16	10		2							3								
	23	6			6			1		1	2			2	6			3	
	30	6		2							2								
		37	4	4	6	2	1	2	4	4	12	6		4	6			3	
2. W.H.	Sept 2	8					2	2		1	3								
	9	10	5		6	4			4	2	3	5		3				4	
	16	8								2	3								
	23	8							2	2	4	6			6				
	30	6									4								
		40	5		6	4	2	2	6	7	17	11		3	6			4	

23.—QUARTERLY SUMMARY.

											LEATHER																
OVERLOOKER	LOOMS	PICKING BANDS			PICKERS			SHUTTLES			STRAPPING.			BUFFERS			BUFFER STRAPS			CHECK ENDS			TOTAL			AVG. PER. LOOM	REMARKS.
1	80	1	15	3	1	3	6		13	10	1	6	6		12	8		8	4		1	2	6	1	3	18·9	

IV. **STORES.**—The prevailing idea regarding books in the Stores Department of a weaving concern is that besides a receipt book, which merely records the date and particulars of each article received, it is only necessary to keep a book for the recording of the consumption of articles or materials which are used by a number of persons or departments, so that comparisons may be made between individual or departmental consumptions, and extravagance be checked. Thus "loom furnishings" are entered against each overlooker in the Delivery Book outlined at No. 22, and summarised at convenient intervals in the Summary Book No. 23, which shews the results of the comparison mentioned, and also the effect of fluctuations in the prices of materials.

As regards stocks, these are not usually booked. The store-keeper is generally expected to keep his eye upon them and order fresh supplies as the old ones become exhausted. It is probable, however, that the foregoing opinion is due to the acknowledged difficulty of arranging a book that shall be sufficiently comprehensive, adaptable to the changes constantly taking place in the nature of the articles dealt with, and convenient for handling. The only satisfactory solution of the difficulty appears to be in the use of a "Card" System, or its variant the "Loose Leaf" System. In many cases these have proved to be admirably suited for the purpose.

THE OFFICE

INVOICING.—An invoice for cloth should give the following particulars:—

Length of each piece.
Width of each ,,
Reed and pick per inch or quarter inch.
Counts of warp and weft threads.
Weight per piece.

Length.—Goods may be bought to either "long or short stick." The former implies 36½ inches to the yard, while the latter means precisely 36 inches. The length may be roughly ascertained by counting the folds made by the plaiting machine.

Width.—The terms "Actual" and "Nominal" are used in the trade to indicate (1) that the width should be taken as stated, or (2) that a certain amount of allow-

ance should be made. "Actual" implies that the width is not less than stated. "Nominal" means that the width of the cloth may vary as much as half-an-inch below width given on contract.

Reed and Pick.—It is best to use counters giving the number of picks per inch, as the fraction of a pick is more readily detected than when quarter-inch counters are used. The terms "Actual" and "Nominal" are also used here with practically the same meaning as in the case of the width of the cloth. Under "Nominal" conditions the number of picks may be 2, 3, or 4 below the stated number. Thus a cloth described as 19×22 "full or actual" should contain 76 ends and 88 picks per inch, but if described as nominal it may have 74, 73, or 72 ends per inch and 86, 85, or 84 picks per inch. If 74×86 it would be termed "2 down," if 73×85 "3 down," and so on.

Counts of Warp and Weft.—"Nominal" and "Actual" are terms likewise used here, and for similar reasons. They must be taken into account when comparing one piece of cloth with another, or in making a complete analysis of the fabric. If the goods are intended for bleaching or dyeing, it is not so important to make this investigation as when they are destined for shipment to the grey state.

ACCIDENTS IN COTTON MILLS:

Preventive Measures.

The British Secretary of State for the Home Department issued in November, 1912, a "Report on Conferences between Employers, Operatives, and Inspectors, concerning Fencing of Machinery, Prevention of Accidents, and Temperature in Cotton Spinning Mills." The Report was prepared by Mr. Gerald Bellhouse, Superintending Inspector of Factories for the North-Western Division; and the conferences on which the Report is based have resulted in a number of agreements that are now generally observed in English cotton mills and factories. The "Notes of Agreement" are here set forth; they offer valuable hints to those responsible for the safe working of cotton machinery, whether in Great Britain or abroad:—

I. General Provisions.

(*a*) On *new* machinery all projecting set-screws on continuously revolving parts shall either be counter-

sunk or be otherwise efficiently protected; where projecting set-screws are placed inside box pulleys they shall be deemed to be efficiently protected.

Projecting set-screws on *existing* machinery are to be dealt with by Inspectors according as the occurrence of accidents may indicate the necessity of countersinking or protection.

(*b*) On *new* cardroom machinery the following wheels shall be plated :—

(1) All driven pulleys.

(2) Pulleys on undershafts of draw frames.

(*c*) Ladders, other than step-ladders, shall be fitted with hooks or other non-skid device—provided that in mule rooms or in rooms where persons work with bare feet, ladders shall not be fitted at the bottom with spikes.

(*d*) Heavy overhead main driving belts or ropes shall be guarded underneath in all cases where there is liability of persons having to pass under them.

Note.—This does not refer to the strap that drives the mules, nor to the rope-race in the engine-house.

(*e*) It shall be obligatory on any woman or girl working about machinery to have her hair put up or otherwise confined in a net.

(*f*) All firms are to be urged to keep a supply of sterilised dressings, which shall be kept available for first aid for any operative who receives a cut or wound.

II. Blowing Room Machinery.

(*a*) Beater covers and the door immediately over the dirt grid shall be fitted with an automatic locking arrangement which renders it impossible to open the covers while the beater is still running, or to restart the machinery until the doors have been closed.

(*b*) The nip between the cage wheels and calender wheels shall be efficiently protected on all machines. On new machines "spectacle" guards shall be provided, extending round the outer edge of both wheels.

(*c*) Fender guards shall be provided for the fan strap side of scutchers, to guard the fan strap and slow motion strap. Provided that on existing machines where the slow motion pulley is driven directly by a strap from the overhead shaft, it shall be optional either to plate the wheel or to protect it by a fender

guard. If the fan strap is on the opposite side to the slow motion strap, each strap shall be protected separately.

(*d*) Projecting ends of beater shafts shall be fitted with loose sleeves, or be otherwise protected.

III. Carding Engines.

(*a*) All feed roller wheels, doffer and barrow wheels, side shaft wheels, calender wheels, and coiler wheels shall be efficientlv fenced.

(*b*) All cylinder doors shall be fitted with an automatic locking motion which will prevent the door from being opened until the cylinder has ceased to revolve, and which shall render it impossible to restart the machine until the door has again been closed.

(*c*) Licker-in covers shall be screwed down so that they cannot readily be lifted while the machine is in motion.

(*d*) In new machinery covers shall be extended as far as is reasonably practicable over the doffer.

(*e*) In new mills there shall be a space of at least 12 inches between the pulleys or the outermost parts between the cards, and at every third card a space of 24 inches.

IV. Drawing Frames.

(*a*) The roller gearing shall be effectively covered, and on new frames the covers shall be automatically locked in such a way that they cannot be lifted while the machinery is in motion.

(It is understood that this rule shall not prohibit the overlooker from putting the lock temporarily out of action when changing the wheels, it being recognised that he must see them running in order to satisfy himself that they are properly set.)

(*b*) The pulley at the end of the frames shall be protected.

(*c*) The undershaft shall be covered.

V. Speed Frames.

(*a*) Headstocks shall be fitted with metal plates to protect all jack-box wheels, and these on all new frames shall be fitted with automatic locks which shall prevent the doors being opened while the machinery is in motion, and shall render it impossible to restart the machine until the door has been closed.

(*b*) Draft change wheels, twist wheels, and carrier wheels, bobbin driving wheels, and lifter wheels shall all be efficiently protected.

(*c*) Bobbin skew gear wheels shall be covered over the top, and these covers shall be extended both in front and behind round the edge of the wheels, except in those cases where the spindles are not cleaned while the machinery is in motion.

(*d*) Spindle skew gear wheels shall be effectively covered. On new frames the covers shall be of metal (other than cast-iron), and on old frames metal covers shall gradually be substituted for wooden ones as the necessity arises for their renewal.

(*e*) Lifter rack wheels shall be securely fenced, the guard to be such that it will effectively protect the nip both as the rail rises and as it falls.

(*f*) All new balance weights shall be cast with the eyelet forming part of the weights themselves.

VI. Self-acting Mules.

(*a*) The guards for middle back shaft scrolls shall be fitted with flanges to protect the intake of the bands and the side of the scroll. The guards for middle draw band and carrier pulleys shall be either fixed to the bottom creel board, or be so fastened otherwise that they cannot readily be knocked aside. The side pieces of the guard shall be extended inwards far enough to completely guard the nip between the band and the scroll.

[This rule was agreed to in principle, but the exact forms of the guards were left to be decided upon later. As the result of further conferences between Inspectors and the representatives of employers and operatives, held during 1913, a detailed Agreement as to the exact form of guards was reached. Particulars of this Agreement are given on p. 542.]

(*b*) On new machines the guards for faller stops shall consist of a cover over the stop. The combined guard and faller stop shall not be deemed to satisfy the requirements of this rule.

(*c*) On new machines the guards for end draw band pulleys shall be extended at least half an inch beyond the end of the pulley.

(*d*) Where persons have to stand on creels to attach driving belts (not countershaft belts), the two creels shall be joined together by timber to form a platform on which to stand, or some other equally safe

method shall be adopted to the satisfaction of the Inspector.

(*e*) In new mills the space behind the mules shall not be less than three feet between the rovings.

(*f*) Metal fasteners shall not be used for overhead driving belts unless the belt itself be securely fenced—provided that this rule shall not apply to metal fasteners consisting of a continuous wire stitching held together by a peg other than a metal peg.

VII. Ring and Throstle Frames.

(*a*) All cogwheels shall be securely fenced.

(*b*) The outer ends of the frames shall be filled in with metal plates.

(*c*) No banding of spindles shall be allowed while the frame is in motion where there is a double tin roller.

CLEANING MACHINERY.

I. Young persons shall not be allowed to clean the following parts of machinery while they are in motion :—

(*a*) Blowing Room Machinery—

No part which requires the removal of guards.

(*b*) Carding Engines—

(1) Sides and backs of cards, except with a handbrush;

(2) Doffer covers, comb-box, top of comb, and top of coiler, except with soft waste or strips;

(3) Other parts not to be cleaned at all while in motion.

(*c*) Speed Frames—

No part of machinery that it has been agreed requires guarding shall be cleaned whilst in motion, nor are the spindles between the bobbin and spindle skew gears to be cleaned whilst in motion, unless the guard for the bobbin skew gear is extended both in front and behind round the edge of the wheels.

(*d*) Self-acting Mules—

(1) Back shaft scrolls, draw band, and carrier pulleys;

(2) Back carriage wheels and back of carriage;

(3) Quadrant pinions;

(4) Back of headstock, including rim pulley and taking-in scrolls;

(5) The whole of the front of the headstock.

It was further agreed that these restrictions should be deemed to apply only to persons under 18 years of age.

TEMPERATURE.

The following temperatures were agreed to as being "reasonable":—

	Max.	*Min.*
Card Rooms and Ring Rooms	80°	60°
Mule Rooms	95°	70°

By this it is understood that the means of heating shall be turned off when the temperature reaches the maximum, and that this agreement shall not be deemed to have been broken if under exceptional climatic conditions the temperature should rise above the figures named without the aid of artificial means. Employers agreed to provide thermometers in the Spinning Rooms.

SELF-ACTING MULES:

The following are the terms of the **Agreement** referred to on page 540.

Fencing of Backshaft Scrolls, Carrier Pulleys, and Draw Bands.—An efficient guard must comply with the following conditions:—

I. **General.** (*a*) Any movable parts of the guards must be provided with fastenings to prevent accidental removal or displacement through vibration. (*b*) The edges of guards made of sheet metal must be wired or beaded (to prevent cuts or scratches). (*c*) The guards must be securely fixed to the floor or to the machinery. (*d*) The guards must be so constructed as to be readily opened out or removed to allow the bands to be easily passed round the carrier pulleys and fitted to the scrolls. (*e*) If the guards are made of sheet metal, the metal should be not less than 24 gauge steel or 20 gauge black iron.

II. **Middle or Intermediate Backshaft Scrolls, Carrier Pulleys, and Draw Bands.** (*a*) The scroll-guard must cover the top and front (wheel-gate side) of the scroll over its entire length; and (*b*) Be provided with flanges at each side to cover completely the sides of the scroll and any key or other projection on it; and (*c*) The space between the back-shaft and the holes in the flanges, through which the shaft passes, must be small enough to prevent the fingers being inserted. (*d*) The guard for the draw bands and carrier pulleys must be continued from the scroll-guard to the floor at the front, back, and sides, to enclose completely the draw-bands and carrier-pulleys. The openings in front (near the floor level) for the passage of the bands, and those at the sides for the purpose of lubrication, must not permit access to the nip between the carrier pulleys and the bands.

III. **End Scrolls and Draw Bands.** (*a*) The guard must cover the top, front, and bottom of the scroll, over its

entire length. The openings in front for the passage of the bands must not permit access to the nip between the scroll and the bands. (*b*) The guard must be provided with flanges at each side to cover completely any key or other projection on the scroll. The flange on the inner side to extend from the top to the bottom of the guard; and that on the outer side to extend from the top and bottom of the guard to the frame end. (*c*) The space between the back-shaft and the hole in the inner flange, through which the shaft passes, must be small enough to prevent the finger being inserted.

INTERNATIONAL ARBITRATION BETWEEN COTTON SPINNERS AND MANUFACTURERS.

Reference was made in 1911 in the Press concerning some proposals of the "Aeltesten der Kaufmannschaft, Berlin" (the largest Merchants' Guild in Germany) for the purpose of simplifying judicial procedure when disputes arise from commercial transactions between parties in England and Germany.

At a meeting (held September 13th, 1912) of the English Federation of Master Cotton Spinners' Associations the Rules of Arbitration for differences between Cotton Spinners and Manufacturers of different countries, as established by the International Cotton Federation, have been endorsed, and they are now used by the Lancashire Cotton Spinners and Manufacturers. The same set of Rules has been adopted in Austria, Belgium, France, Germany, Holland, Italy, Russia, Spain, and Switzerland, and a panel of arbitrators has been appointed in each country.

These Rules, a copy of which is given below, go a considerable step farther than the simplification of the Commercial Law proposed by the German Guild; they eliminate entirely judicial proceedings, and leave the settlement of the points in dispute in the hands of experts of the trade.

The idea of Arbitration in these matters was first introduced by Mr. J. M. Thomas, one of the delegates of the English Federation, at the Sixth International Cotton Congress held in 1909 at Milan, and since then the International Committee have been at work in establishing the Rules and adapting them, as far as possible, to the legal requirements of each affiliated country.

Several disputes have already been settled on the basis of the Rules of the International Cotton Federation.

Rules of Arbitration for Differences between Cotton Spinners and Manufacturers of Different Nations.

RULE I.—In case of any difference or question relating to the meaning of fulfilment of the present contract, or as to the rights of the parties under it, the same shall be referred to arbitration under the Rules of Arbitration between Cotton Spinners and Manufacturers of different nations adopted by the International Committee at their meeting in Berlin.

RULE II.—The clause mentioned in Rule I. involves the obligation for the parties who have inserted it in a contract to refer in a friendly way any difference or question which cannot be mutually settled relating to the meaning or fulfilment of a contract, or to the rights of the parties under it to the decision of arbitrators, chosen from the Arbitration Board of the country in which the arbitration, as stated in the following Rule III., shall take place.

RULE III.—The arbitration shall take place in the country of the vendor, except when the difference or question relates to the quality of or to alleged defects in the goods sold, in which case it may take place in the country where the goods are lying. Should the difference or question be more than one and/or one of the parties claims for quality of or to alleged defects in the goods, and the other for any other reason the place of arbitration shall be the country of the vendor.

RULE IV.—Within one month of the day in which either of the parties has given notice in writing to the other party to appoint arbitrators, a compromise act or submission shall be drawn up by the parties jointly, in which the nature of the difference or question which has arisen shall be explained. Arbitrators, to be selected from the Board of Arbitration of the country in which the arbitration will take place, as at Rule III., will then be appointed, it being understood that the dispute has to be settled on a basis of equity without procedural formalities, the parties foregoing their right of appeal against the decision of the arbitrators and agreeing to accept the decision as final, the arbitrators being considered friendly composers.

In case of dispute as to the country in which the arbitration should take place, arbitrators shall be appointed in the country of the vendor, and they shall first of all decide as to their competency. If they decide that the arbitration should take place in the country of the vendor they are to proceed with the arbitration; if they decide otherwise they shall state in what country the arbitration should take place, and shall instruct the parties to appoint arbitrators in that country, and arbitrators shall be appointed accordingly and a new compromise act or submission be drawn up if necessary.

RULE V.—The two parties shall, if possible, appoint by mutual agreement a single arbitrator, or, if they consider a

single arbitrator insufficient, three arbitrators. In the event of the parties being unable to agree upon the arbitrators, then, prior to the signing of the compromise act or submission, each party shall appoint one arbitrator in writing, and these two arbitrators shall together appoint the third one.

If the two arbitrators are unable to agree upon a third, the third shall be appointed by the president of the association of the country in which the arbitration will take place. The appointment of the third is to be mentioned in the act of compromise or submission.

Rule VI.—The arbitrator or the arbitrators, as soon as they get notice of their appointment, and within ten days from the date of reception of the compromise or submission, shall sign a document, accepting the office of arbitrator and stating the place where the arbitration is to be held; otherwise they shall give prompt notice to the parties.

Rule VII.—In any case where more than one arbitrator is appointed, the arbitration shall take place in the presence of three arbitrators, or in two distinct stages, the two arbitrators sitting at first and the third joining only in case of disagreement between the two arbitrators to decide the dispute. The choice of either of these two methods, as well as any decisions about questions of procedure, will be regulated by the rules of the arbitration for the time being of the association of the country in which the arbitration is taking place, and previously approved by the Committee of the International Federation, and in default, by the laws of the country itself.

Rule VIII.—The arbitrators shall decide in the sentence by whom and in what manner the cost of the arbitration shall be borne.

Rule IX.—Should either of the parties having inserted in their contract the clause mentioned in Rule I., or another of equal value, refuse to draw up the act of compromise or submission, which constitutes the arbitration, the other party, without prejudice to eventual legal action, may give notice of this default to the Board of the association to which the defaulting party belongs, in order that it may call the said party to the observance of the obligation imposed by that clause.

In the event of a new refusal, the willing party may, through its own association, claim the assistance of the Committee of the Federation, which, after examination of the grounds of the refusal, may order the cancellation of the membership of the unwilling party, and may remove the name of such party from the list of the members of any association registered at the Federation, and make public the steps taken and the grounds which determined its action.

(Signed): Charles W. Macara, President.
Arno Schmidt, Secretary.

15, Cross Street, Manchester,
13th September, 1912.

COTTON SPINNING, WEAVING, &c.

British Patents:

Complete Specifications Accepted, Nov. 5th, 1913, to Oct. 28th, 1914.

1912

28,314 Dickinson & Butterworth. Warping machines.
28,888 Redman. Loom shuttle pegs.
29,593 Cockshott & Smith. Shuttle easer
25,201 Cook, Leigh, & Jowett. Lappets & thread guides for spinning
25,783 Leeson. Winding yarn & thread
28,315 Butterworth & Dickinson, Ltd. Expansion reeds for beaming, etc.
25,925 Threlfall & Barnes. Winding-on motions for mules
26,216 Prestwich. Opening and cleaning fibres
27,178 Wood & Lang Bridge, Ltd. Apparatus for damping yarn
26,705 Bradley. Looms for lath fabrics
27,467 Smith & Shackleton. Picking mechanism
28,245 Farrar & Whitehead. Dyeing machines
28,008 Smith. Ring spinning frames
28,795 Smith & Perks. Weft-replenishing mechanism
29,102 Leeson. Unwinding yarn from hanks
29,103 Leeson. Reels for holding skeins
26,060 Daglish & Lorkin. Winding mechanism
29,316 Smith. Drawing & spinning short fibres
29,787 Brandwoods. Beam-warping machines
30,015 Smith. Building motion for spinning frames
25,645 Berthold. Binding together skeins of yarn
25,833 Berthold. Do.

1913

1,019 Blacker. Removing the gudgeons of weavers' beams
2,041 Rigby. Spinning mules
3,982 Ward & Ward Bros. (Blackburn), Ltd. Dobbies
5,744 Glover. Cloth finishing machinery
5,839 Bradshaw & Dugdale. Weft replenishing mechanism
6,087 Toone. Checking jacquard pattern cards
6,985 Gardiner. Weaving tubular fabrics
8,046 Pillsbury. Shuttle release for looms
15,119 Smith. Securing flanges to weavers' & warpers' beams
597 Varley. Cleaning faller-gills of roving, etc., fra'es
9,949 Mueller. Spindle bearings
13,585 Hutchison. Reeler for jacquard card cylinders
5,048 Newton. Stair-tread coverings
8,016 Psarski Dyeing Machine Co. Dyeing machine
10,101 Bauer. Stop-motions for looms
15,582 Daudelins. Shuttles for weaving
[illegible]hem. Yarn clearers for spinning frames
12,647 Gerstberger. Thread-brakes for winding and warping
22,381 Walsh. Shuttles
2,845 Ainsworths. Spinning mules
2,988 Jones. Buffers of mules
3,728 Newsholme. Doffing mech.
5,863 Coopers. Shuttle-changing mechanism
6,072 Wilh. Bleyle. Oiling yarns.
11,613 Casablancas. Mechanism for drawing fibres
18,303 Psarski Dyeing Machine Co. Dyeing machine
21,086 Nisbet. Opening and cleaning cotton

Complete Specifications Accepted.—*Continued.*

1913

24,722 Callebaut and De Blicquy. Dyeing & bleaching machines
773 Worden. Looms for leno fabrics
3,080 Wilcock & Others. Sizing threads
4,939 Higginson & Arundel. Yarn-preparing machines
8,079 Crompton & Knowles Loom Works. Pattern mechanism for looms
8,315 Wilding Bros., Ltd., & Parnaby. Regulating tension on warp in looms
22,801 Cooper. Spinning frames
2,668 Crabtree. Spinning fra'es
5,848 Atherton. Connecting pickers to picking-sticks
6,218 Hall. Loom shuttles
6,325 Scott. Local humidification of looms
9,623 Crompton & Knowles Loom Works. Magazines for weft-replenishing looms
15,761 Chernack. Let-off mechanism for looms
16,005 Grandsire. Treating spun materials
21,054 Nettel. Swifts
436 Brandwoods. Beam for use in dyeing
551 Brandwoods. Dyeing or bleaching upon beams
15,441 Hargreaves. Conditioning warps in looms
19,562 May & Preissler. Warp stop-motions
6,636 Tidswell & Mills. Shuttle-relieving motion
433 Bowker. Thread-guiding devices for spinning
492 Geb. Staubli (Firm of). Removing travellers from spinning rings
1,534 Walls. Applying drag to spinning bobbins, etc.
1,688 Furness. Dyeing machines
19,760 Whitin. Spindles
1,034 Draper. Spinning mules
1,249 Wood. Guiding fabrics to stentering machines
1,353 Holt. Yarn-guides for winding

1913

4,202 Haring. Cotton-picking machines
7,628 Taylor & Earnshaw. Threading shuttles
8,526 Shaws. Conditioning of warps
18,206 White & Smith. Looms for weaving
19,397 Tillmanns. Manufacturing name-tapes
22,696 Siemens - Schuckertwerke Ges. Ring spinning machinery
22,934 Stiehle. Spinning cans
26,775 Trypani. Ginning
1,617 Western Electric Co. Winding machines
2,350 Chisnall & Briercliffe. Drawing, slubbing, & roving machines
3,203 Davies. Mules
3,451 Morton. Drawing rolls of spinning frames
4,000 Rosenthal. Automatic changing of loom shuttles
4,448 Redman. Cloth rollers of looms
10,848 Duckworth & Howard & Bullough, Ltd. Preventing breakage of ends on starting spinning machines
11,387 Tankard & Speight. Tubes for cap spinning frames
15,992 Chadwick. Indicating apparatus used in forming bobbins, etc.
19,737 Newsholme. Doffing mechanism for spinning frames
10,630 Battersby. Driving the rollers of preparing and spinning machines
13,210 Fitton. Dyeing machines
13,879 Wardwell. Stopping device for spindles
18,855 De Lagatinerie. Scutching machines
27,243 Rotter. Manufacture of yarn
27,414 Kay and Potter. Loom shuttle-boxes.
2,644 Mitchell. Preparation of coloured warps
2,801 Lee & Barlow. Marking fabrics

Complete Specifications Accepted.—*Continued.*

1913

5,743 Shaw & Cook. Roller guards
9,817 Walburn & Livesey. Loom shuttles
16,189 Mylchreest. Stop-motion for doubling frames
19,510 Kramer-Hagist. Shuttle-races for looms
23,435 Kent. Apparatus for holding hanks
23,540 Fitchburg Bobbin-Cleaning Machine Co. Stripping filling from bobbins
27,514 White & Smith. Woven fabrics
2,944 Adair. Cutting fabrics
3,600 Harrison. Delivery stopping: spinning & doubling frames
3,870 Bohle. Stripping apparatus for carding machines
5,278 Calico Printers' Association, Ltd., & Muir. Printing shawls, etc.
14,175 Marsden & Others. Feed of cotton gins
4,316 Levinsteins. Printing fabrics
9,745 Reis. Packing tapes
20,088 F. Bernhardt (Firm of). Treating loose fibres
8,122 Bolton. Woven fabrics
8,540 Holt & Others. Locking & releasing reeds
9,955 Schorigin & Levin. Shuttle-boxes
12,097 Ramberg. Ring-spinning rings
15,252 Higginson & Arundel. Thread guides for winding machines
19,873 Chapman. Spinning spindles
6,423 Stells & Hey. Spinning & doubling machines
8,535 Burtinshaw. Thread guides for spinning frames
8,800 Geb. Schwartz. Weaving with coloured warps
13,057 Higginson & Arundel. Detector mechanism for doubling machines
16,400 Froelich. Jacquard machines

1913

17,259 Winkler. Yarn-drying apparatus
18,282 Mallott & Others. Reed-motions for looms
26,030 Welcomme. Jacquard mechanism
6,915 Courtauld & Co. & Linfoot. Applying effects to fabrics
12,709 Higginson and Arundel. Doubling machines
13,378 Southey. Let-off mechanisms for looms
19,683 Campbell. Carding machines
28,623 Beckers & Le Hanne. Loom reeds
13,854 Fine Cotton Spinners' and Doublers' Assoc., Ltd., and Rose. Underclearers for cotton drawing frames
14,373 Jagger. Guards for slubbing, intermediate, and roving frames
15,773 Lacroix, Desautels, & Burdick. Twisting & doubling frames
29,834 Taylors. Woven figured fabrics
7,263 Small. Reeling machines
12,394 Roscoe. Threading shuttles
13,775 Mycock. Straightening selvedges of fabrics
16,326 Lodge. Buffers for pickers
21,985 Wilkinson. Watered fabrics
28,990 Starkie. Take-up motions of looms
7,917 Hay. Removal of fibre from carding cylinders
8,023 Hampe. Flyer spinning & twisting machines
11,325 Smith & Jonas. Straps of loom crank-arms
12,486 Sella. Lubricating spindles
17,551 Fisher. Dabbing-brush motions of combing machines
8,270 Brown. Power-transmitting for spindles
10,373 Corsi. Electrically operating jacquard
12,452 Miller. Warp-drawing machines

Complete Specifications Accepted.—*Continued.*

1913

22,096 Tomlinson & Others. Stop-motions for thread-winding
22,201 Gabler Webstuhle, Akt.-Ges. Thread-shearing device for looms
22,961 Lowden & McLaren. Conditioning warp in looms
28,480 Wildt & Co. & Wildt. Stop-motions for winding machines
9,096 General Electric Co. Speed-controlling for spinning frames
13,493 Oldham & Fallows. Shuttles
16,654 Fletcher. Pile cutting
20,151 Sykes. Warp stop-motions
26,445 Kops. Elastic fabrics
8,995 Berry & Isherwood. Ring spinning machines
11,538 Carman. Filter press fabrics
11,545 Stroud & Soar. Vertical looms
17,363 Maxwell & Christie. Multiple-ply fabric belts.
23,974 Streiff. Cleaning cotton
26,409 Dunn. Elastic webbing
27,686 Barker & Toulson. Curling yarns
7,120 Bohmer & Trubenbach. Combing machines
10,026 Walker & Spink. Looms for pile fabrics
10,327 Lister. Spinning
12,132 Thomason. Velvet cutting devices
14,702 Hahn. Mercerising apparatus
15,867 Szilard. Singeing yarn fabrics
21,095 Higginson & Arundel. Cop or pirn-winding machines
22,975 Cochrane. Shuttles
29,432 Sachs and Others. Spinning spindles
29,900 De Saint-Romain. Bearing for spindles
29,978 Zipper. Picking motions
15,806 Ellison & Others. Pickers
16,738 Hahn & Others. Shifting hanks in dyeing
20,622 Hollingworth. Thread-cutting mechanism for looms

1913

8,414 Debuire. Woven fabrics
10,865 Dew. Manufacture of yarns
16,858 Hablutzel. Treating hanks of yarn
17,651 Hodgson. Weighting motion for loom warp beams
22,877 Crompton & Knowles Loom Works. Double-pile fabrics
23,008 Wade. Picking motions
24,236 Rumpf. Mercerised cotton
26,975 Pickford. Guards for mules & twiners
28,351 Gordon. Doubling machines
14,654 Cotton & Stead. Ring spindles
18,780 Hollingworth. Pick-finder mechanism
19,522 Heymann. Treating cheeses and cops
17,591 Hartley. Dobbies
19,449 British Northrop Loom Co. Shuttles
21,940 Louis Hermsdorf & Teufer. Finishing cotton yarns & fabrics
26,814 Diack. Shuttle-box devices
29,107 Purves. Spinning
29,308 Siemens - Schuckertwerke Ges. Flyer frames
13,176 Leeson. Traverse mechanism for winding yarn
13,689 Cochrane. Piece-dyeing machine
13,776 Martin & Hind. Punching jacquard cards
19,392 Hartley & Johnson. Spinning machines
23,641 Schüller. Mixing loose fibrous material
28,441 Auerbach. Shuttle changing mechanism
28,657 Carl Hamel Akt.-Ges. Delivery spindles of spinning machines
14,448 Hilling & Collis. Spinning frames
18,196 Crompton & Knowles Loom Works. Feeler mechanism for weft-replenishing looms
18,687 Mycock. Cloth expanders
21,148 H. Ballantyne & Sons, Ltd., & Watson. Carding engines

Complete Specifications Accepted.—*Continued.*

1913

21,785 Pudumjee. Feeding devices for textile machinery
24,576 Jones. Loom shuttles
13,770 Cook & Durrant. Guiding fabrics into stenters
13,831 G. Hodgson, Ltd., & Hodgson. Loom dobbies
14,184 Fallows & others. Ring spindles
14,374 Breadner. Woven sacks
17,643 Lloyd. Treatment of fabrics
18,645 Redman. Shuttles
20,432 Calverts. Shuttles
23,045 Fletcher. Lace
14,907 Bourne & Chambers. Removing fluff, &c., in gassing or winding yarn
15,310 Pickett. Breaking & opening cotton
23,678 Pateson. Conditioning warps in looms.
12,483 Kozlowski. Stopping travel of broken thread in twisting.
12,769 Daniels. Warp stop mechanism.
14,701 Hahn. Machines for finishing textiles
15,338 Leeson. Winding yarn
23,499 Northrop Loom Co Shuttles
29,646 J. Hetherington & Sons, Ltd., & Snape. Roller gearing of mules and ring frames
17,971 M'Murray & Knowles. Washing apparatus
21,411 Asa Lees & Co. & Taylor. Slubbing frames
22,055 Klein. Manufacture of yarn
22,072 Billington. Drawing rollers of mules
24,721 Callebaut. & De Blicquy. Dyeing machines
24,959 Fielding. Guards for spinning frames
26,073 Fincato. Apparatus for washing yarns
28,503 Elsassiche Maschinenbau-Ges. Printing textiles
16,037 Walton. Selvedge motions of looms
16,331 Leeming. Loom dobbies
16,415 Hodson. Shuttle checking

1913

19,704 Barbour, Sherriffs, & Craig. Removing dust from fibrous material
20,399 Sibson & Allsop. Dyeing machines
20,446 Walker. Bobbins used in spinning
21,101 Billet. Change-speed gears for spinning frames
22,572 Wilde. Shuttles for looms
29,181 Dudeff. Spindles of spinning machines
14,356 Greenhalghs. Willows
16,867 Stubbs, & J. Stubbs, Ltd. Yarn winding machines
17,446 Thompson. Weft cutting devices for automatic looms
19,977 G. Hodgson, Ltd., & Hodgson. Dobbies
23,944 Staublis. Placing runners on rings
25,691 Brachter. Mercerising cotton piece-goods
25,877 Bradshaw & Dugdale. Loom swells
25,982 Bradshaw & Dugdale. Automatic weft-replenishing looms
26,670 Wood. Actuating indicators in looms
27,286 Whyte. Shuttles to facilitate threading
29,985 Piccioni. Production of patterns, &c., in woven fabrics
17,230 W. McGee & Son, & Walls. Producing bound skeins of yarn
17,768 Thame. Manufacture of yarn
24,382 Kaumagraph Co. Applying transfer stamps to fabrics
24,775 Pilling, & Howard & Bullough, Ltd. Driving mechanism of carding engine doffers
18,197 Ross & Cunningham. Jacquard & like machines
20,935 Colin. Ring spinning frames
21,601 Worsley & others. Dobbies
26,031 Welcomme. Jacquard mechanisms for looms
15,595 Applegate. Apparatus for dyeing

Complete Specifications Accepted.—*Continued.*

1913

18,100 Vincent. Decorticating fibrous matter
18,633 Fielding. Loom shuttles
25,195 Holming. Ball-bearings for spindles
25,987 Ormerods. Picker
26,386 Illingworths. Preventing spinner's double
26,669 Stubbs, & J. Stubbs, Ltd. Pirn-winding frames
14,022 American Warp Drawing Machine Co. Pattern mechanism for warp drawing
16,873 Taylor & Haworth. Humidifying yarns, threads, and slivers
19,119 Sloper. Stretching fabrics
19,457 Downs & Pearson Truck for warp beams
19,701 Stells & Welch. Doffing mechanism for spinning and doubling machines
24,076 Crompton & Knowles Loom Works. Woven fabrics
24,077 Crompton & Knowles Loom Works. Tuft fabric looms
25,438 Orme & others. Counting devices for textile machinery
20,506 Moreau. Drivers for looms
24,090 Grey. Operating doffing combs of carding engines
25,223 Lunn & others. Fringing motions for looms
27,086 Bakers. Locking and releasing loom reeds
20,697 Lee. Fabrics with printed warps
20,731 Leeson. Winding machines
24,078 Crompton & Knowles Loom Works. Tufted fabrics
25,986 Duckett & others. Yarn clearing mechanism for winding machines
17,814 Perkin & others. Treatment of cotton against inflammability
17,815 Do. do.
20,471 Higham & Skelton. Waterproofing canvas, etc
21,426 Howard. Securing box backs to sley swords

1913

21,800 Geo. Hodgson, Ltd., & Hodgson. Weft stop mechanism for looms
21,843 Thame. Manufacture of thread
25,345 Abell. Damping fabrics
26,172 Jacobs. Waterproof fabric
27,808 Rushton. Thread guides for winding and gassing
7,422 Edwards & others. Bobbin winding mechanism
25,009 Reynolds. Creasing fabrics
26,751 Bradford Dyers' Assoc. & Thornber. Beams.
28,221 Crompton & Knowles Loom Works. Pile fabrics
30,025 Riley & Co. Cop-dyeing machinery
18,461 Bhisey. Loom shuttles
21,877 Burtinshaw. Thread guides for spinning, etc.
22,595 Raus. Dyeing apparatus
22,787 Hope. Guards for mules
23,160 Smith & Shackleton. Weft stop-mechanism
24,392 Newsholme. Doffing for spinning, etc., frames
28,101 Boyds. Cop winding machines
28,470 Croasdale. Shuttle-pegs
29,928 Ainley. Treating piece-goods and yarns
22,757 Pallares. Changing shuttle bobbins in looms
23,402 Smith & Young. Letting-off motions of looms.
25,748 Holmes. Damping warp in looms
29,337 Ashley. Let-off devices for looms

1914

732 Mitchell. Creels
2,785 Dewhurst & Sons, Ltd., & Preston. Stop-motions of winding machines
352 Burnham. Fabric-folding devices
2,576 Sissons. Flyers
6,068 Maschinenfabrik Ruti. Weft-replenishing mechanism
6,255 Maschinenfabrik Ruti. Weft feeler mechanism for looms

Complete Specifications Accepted.—*Continued.*

1914

6,031 Jagger. Guards for slubbing frames
5,191 Barritt & others. Loom shedding motions
1,948 Liebschner. Connections between picking-sticks and bands
5,661 Fievet. Carding machine
7,317 Lilienfeld. Finishing fabrics and spun goods
2,010 Spannagel. Pile or loop fabrics
7,657 Brown. Spindles for twisting, etc., machines
7,658 Do. do.
2,967 Mossop. Loom shuttle threading
3,799 Chmielewski. Thread stop motions for twisting machines
4,827 Schilde. Moistening yarn
7,303 Liebscher. Carding engines
8,447 Bourcart. Apparatus for self-acting mules
9,178 Suthers & Suthers. Threading loom shuttles
33 Austin. Woven tapes
201 Stone. Apparatus for drying fibrous materials
2,164 Dutschke. Imparting a gloss to cotton
11,758 Asa Lees & Co., & Guy Spindle reversing motion for mules and twiners
5,309 Maly. Treatment of sliver or roving
2,193 Maschinen fabrik Schweiter Akt.-Ges. Winding frames

1914

4,566 Roberts. Stopping delivery of roving in spinning machines
890 Berry. Weavers' reed hooks
1,449 Ezbelent. Producing velvet-like fabrics
6,887 Wardwell. Yarn-winding machines
9,358 Tedeschi. Plaiting machines
9,215 Whittall & Kermode. Hand-threaded shuttle
10,235 Williams. Ring-spinning machines
12,195 Starkie. Loom take-up motion
7,943 Thomsons. Guards for ring frames
11,462 Gardner & Cunningham. Loom crank arms
1,831 Wilson Bros. Bobbin Co. Shuttle pegs
2,447 Leigh. Warpers' and weavers' beams
3,519 Anderton. Slubbing, intermediate, and roving machines
9,529 Thomson. Doffing for ring spinning machines
16,273 Hetherington & Sons, Ltd. Carding engines
18,905 Hetherington & Sons, Ltd. Travelling flat carding engines
18,906 Do. do.
6,886 Wardwell. Yarn-winding machines
6,888 Do. do.
10,711 Graf. Card clothing

Insurance companies' statistics show that the largest number of fires in cotton mills occur in the mule spinning rooms, and are caused chiefly by friction in the machine headstocks.

Regulating Oil Cans.—Specially constructed to prevent the spilling of oil when lubricating roller-necks, and other parts of spinning frames that require frequent application of but a few drops of lubricant at a time. The can is fitted with a small valve near the neck of the spout, which is opened or closed by turning a small screw near the handle.

SECTION X:

VENTILATION, ETC.

MOTIVE POWER

BOILERS

ENGINES, SHAFTING

DRIVING

COTTON WEAVING.

Humidity Table for Attaining Good Results.

At Temperatures varying from100 deg. to 40 deg. F.

Dry Bulb.	Wet Bulb.	Relative Humidity.	Weight of Vapour Grains.	Dry Bulb	Wet Bulb.	Relative Humidity	Weight of Vapour Grains.
100°	85·5°	46%	9·2 grs	70°	60·0°	53%	4·3 grs
99	84·0	46	9 0	69	59·0	53	4·1
98	83·6	47	8·8	68	58·3	53	4·1
97	82·3	47	8·6	67	57·3	53	3·9
96	81·3	47	8·3	66	56·3	53	3·8
95	81·0	48	8·3	65	55·5	53	3·7
94	80·0	48	8·0	64	54·5	53	3·5
93	79·0	48	7·8	63	53·7	54	3·4
92	78·6	49	7·7	62	53·0	54	3·4
91	77·7	49	7·6	61	52·0	54	3·2
90	76·7	49	7·3	60	51·0	54	3·1
89	76·3	50	7·2	59	50·3	54	3·1
88	75·3	50	7·0	58	49·3	54	3·0
87	74·6	50	6·9	57	48·3	54	2·8
86	73·5	51	6·6	56	47·5	54	2·7
85	72·6	51	6·5	55	46·7	55	2·6
84	72·0	51	6·3	54	46·0	55	2·6
83	71·0	51	6·1	53	45 0	55	2·5
82	70·0	51	5·9	52	44·3	55	2·5
81	69·3	51	5·8	51	43·5	56	2·4
80	68·6	52	5·7	50	42·5	56	2·3
79	67·7	52	5·5	49	41·7	56	2·2
78	66·7	52	5·4	48	41·0	57	2·2
77	65·7	52	5·2	47	40·2	57	2·1
76	65·0	52	5·1	46	39·2	57	2·0
75	64·0	52	4·9	45	38·4	57	2·0
74	63·0	52	4·7	44	37·8	58	2·0
73	62·3	52	4·6	43	36·8	58	1·9
72	61·3	52	4·5	42	35·6	58	1·8
71	61·0	53	4·4	41	35·0	58	1·7
				40	34·2	58	1·6

VENTILATING AND HUMIDIFYING.

The following notes are intended to convey a general idea of how the different departments in a cotton mill should be dealt with, in regard to ventilation, and the removal of steam, dust, etc., from the workrooms.

Card Rooms.—Fans 24 in. and 30 in. dia. are usually adopted for removing the floating dust in the card room. They are invariably placed in the window recesses, on the side of the carding engines opposite to that on which the preparing machinery stands.

Mule Rooms.—Small fans are usually installed in these rooms in order that a good distribution of air may be secured without perceptible draught.

Ring Rooms.—To reduce the high temperature usual in these rooms, it is advisable to use fans for forcing in and distributing the fresh air from the outside.

Gassing Rooms.—Fans should be fixed in the roof of the building and fresh air inlets provided underneath each frame, so that the air in its passage to the fan carries with it the fumes and calcined fibres.

Sizing Room.—The steam given off by the sow-box and drying cylinders of the machines may be removed by fixing a fan in the existing trunks. Where there are a number of machines, the trunks from each may be connected to one main trunk, and a larger fan should be used for the installation.

Steam Removing Generally.—The sources of steam should be hooded over, with a fan fixed inside every hood for drawing away the steam. The air entering the room where the steam is made should be warmed as it enters, by being confined and passed over heated surfaces, such as steam pipes, etc.

"HUMID" COTTON CLOTH FACTORIES.

Ventilation and "Steaming."

British legal requirements are :—"The arrangements for ventilation shall be such that during working hours in no part of the cotton cloth factory shall the proportion of the carbonic acid (carbon dioxide) in the air be greater than nine volumes of carbonic acid to every 10,000 volumes of air." It has, however, been the practice of the Department, with the assent of the employers and operatives, to regard the air of a weaving shed as substantially conforming to the standard if the proportion of carbonic acid does not exceed that in the open air

by more than 5 parts in 10,000. This object is generally attained by fixing a number of small fans, well distributed for forcing fresh air into the shed, and calculated to supply 2,000 cubic feet of air per hour to each person.

HUMIDIFICATION.

In humidifying or moistening the atmosphere of mills, the conditions of one building as compared with another may vary considerably, and may easily affect detrimentally the carrying out of some particular scheme, which otherwise to all appearances should serve its purpose well. Again, in the case of a weaving shed, for example, one part may require treatment different from another part and this may have a material effect upon the duties of the weaver, and on the cloth woven.

A Humidifier should give just the right degree of humidity to the atmosphere without involving the risk of drops falling on to the goods or machines below, and should at the same time act as a Ventilator. The water should be reduced to an infinitely fine state of division, and the atmosphere for each particular process should be so arranged and maintained as to give the best possible conditions all through the year, irrespective of outside atmospheric conditions. The air entering the humidifier should at all times be filtered.

SOME SYSTEMS IN USE.

Without Distributing Pipes.

Arrangement No. 1.—Consists in placing at intervals, and at a determined height from the ground of each floor, a number of cylinders connected with feed and return pipes, which are supplied with water under pressure by means of a suitable pump either direct-acting or power-driven. The cylinders are the Humidifier proper, and their function is to disperse into the atmosphere a quantity of water, infinitely pulverised, sufficient to fill with moisture the spaces of air between them; to introduce the higher stratum of air in the room into the body of the cylinder through the upper portion, and to expel it, charged with the vapour, through the lower portion, thus keeping the air of the room in continual circulation.

Arrangement No. 2.—Somewhat similar in principle to No. 1, and placed in the room at suitable distances apart. The water is conveyed to each apparatus through wrought-iron pipes, one of which supplies the water under pressure and the other receives the waste and re-

turns it to a tank, where it is filtered and used over again.

With Distributing Pipes.

Arrangement No. 3.—In which the humidified air is obtained from one main supply and distributed throughout the room by main ducts. A sheet-metal box is provided, in which a constant supply of water is kept. The humidifier proper obtains its supply from this tank by means of a belt-driven pump, and delivers it through sprays to the upper surface of an air filtering box, from which it drips and returns to the storage tank. The water in the apparatus is warmed by steam-heated pipes, and the air is humidified while passing through the moistened filtering material.

Arrangement No. 4.—In which the air supply is drawn from the outside through vertical tubes provided with coils of steam-heated piping. The heated air then encounters a spraying device, and thereby obtains its moisture, after which it is blown by means of fans along the distributing pipes.

Arrangement No. 5.—In which the apparatus consists of a set of heating batteries, and a large cylindrical cast-iron tank, built up in sections, and divided into different compartments. In each of these compartments rotates a filmer or rotor, built up after the manner of a pulley, with a very large surface exposed to the water. This is partly submerged, and thus revolves in the water in the lower half of the tank, and out of the water in the upper half, where it meets the current of hot or cold air, into which the water on the surface of the rotor evaporates. Each compartment is also fitted up with heating pipes, so that when used as a heater the water can be heated as well as the air. At the end of the rotors is attached a powerful centrifugal fan, which draws the air through the humidifier and then distributes it by means of the ducts to the shed, the winding and warping rooms, or wherever the humidity may be required.

Arrangement No. 6.—Consists of a series of humidifiers each of which consists of a powerful fan, working in conjunction with a small helically-bladed beater, which has a high rate of velocity. This latter is partly submerged in water, and, revolving, carries round with it the water, which breaks up into minute particles. These again are further atomised by the action of the fan mentioned, and are blown into the room mixed with the current of air created by the fan. The air, with the water thus held in

suspension, is distributed by means of a tube or duct, with which each generator is provided. To equalise the distribution the tubes are each formed with short branch tubes, the ends of any one of which can be readily closed when moisture at that particular point is not required. The air supply for the fan is drawn through a shaft communicating with the outside; but when it is desired to redistribute the whole or part of the already moistened air, the outside supply is diminished accordingly, and its equivalent is obtained through a short branch pipe extending into the room. This latter is provided with a filtering grid to prevent any fluff or objectionable substance from entering therein.

When it is desired to distribute warm moistened air through any particular generator, the air is heated on its way to the fan by encountering a coil of steam piping fixed in the upright shaft mentioned.

Applying the Moisture Direct to the Warp Threads.

System I.—In which the moisture (which consists of moistened air) is directed from a slotted tube situated in close proximity to the warp threads of each individual loom, and each loom is provided with a separate appliance, to regulate at will the degree of moisture delivered in accordance with the character or quality of the warp in that particular loom. The moistener proper consists of an induction tube connected with the branch pipe, and contains a nozzle, which terminates in proximity to a contracted portion of the induction tube. This latter is in valve communication with the upper end of a receptacle containing the water for mixing with the air. A complete installation for a series of looms embodies a main supply-pipe, extending along the back alley between the looms and underneath the floor or overhead, as the case requires. Through this pipe air is directed from the outside, under pressure by means of a compressor, and connection is made with the moistener of each loom by a branch pipe.

System II.—Consists of a metal trough containing water, in which is partly submerged a roller. The upper surface of the roller comes into contact with the warp threads, and as it revolves conveys to the threads whatsoever degree of moisture is required. The water is distributed evenly over the surface of the roller by a wiper made of a felty substance, which is secured to one side of the trough. The roller receives its motion from the oscillating back-rest of the loom, by means of the

ratchet-wheel arrangement. When it becomes necessary to vary the degree of moisture applied, the speed of the damping roller is altered by increasing or decreasing the stroke of the ratchet pawl.

For ascertaining the percentage of moisture in cotton mills, it is necessary to use **Hygrometers.** These are usually composed of two bulb thermometers (one wet and one dry) carefully graded on their own separate stems. The bulb of the former is covered with a small piece of muslin, which is kept moist by connection with a small reservoir of clean soft rain-water (or distilled water) directly underneath. Both thermometers are mounted independently, and the temperatures of air and evaporation are given by the direct readings of both. By comparing these readings with tables provided with the instrument, the precentage of humidity is ascertained. (For Table, see page 554.)

An instrument is now made which dispenses with the need of the above tables.

AIR PURIFICATION.

In ventilating mills and workshops it is essential that all particles of dust and foreign matter contained in the air should be removed therefrom before it is allowed to enter the building. For this purpose air washers or air "filters" are used. They should be self-cleansing, so that there can be no accumulation of deposit in the apparatus. Several types are in use, one of which is constructed as follows :—

A specially formed wheel of open construction revolves in an iron tube of suitable section. A small jet of water plays on the centre of the wheel, whence it is dashed by centrifugal force and by a series of steps traversing the incoming current of air. The water is thus broken up into a fine spray, and mixes with the air current, which it cuts at right angles, carrying with it the impurities the air may contain.

Dust Separators.—Employed in removing dust and other foreign matter given off by material during the process of manufacture. Usually constructed in the form of a cone, with the upper portion parallel. In the centre of this latter is a pipe of smaller diameter, and into the annular space thus provided the mixture of air and dust is blown. The separation takes place by gravitation, the air passing up the centre pipe, and the dust through a small outlet in the bottom of the cone.

SPRINKLERS, &c.

The ever-increasing use of sprinklers in mills and industrial works generally is due to the fact becoming more widely known that it is not alone the fire loss that has to be guarded against—(this can be covered by insurance)—but also the absolute dislocation of business and the loss of customers, which is not covered by the insurance.

Of about 45 million spindles represented by the English Federation of Master Cotton Spinners' Associations, 90 per cent. are protected from fire by automatic sprinklers. The installation of sprinklers in a textile mill reduces the premium for insurance by from 33 per cent. to 50 per cent. It is also to be borne in mind that when a fire starts and operates a sprinkler immediately, it also operates a fire-alarm, thus drawing attention to the outbreak, even when the work is not in progress, and the mill is empty of people; and the same alarm will be raised to sound if any leakage should accidentally occur in the installation.

Sprinklers should be installed in accordance with the rules of the Fire Insurance Companies, which lay down that the horizontal distributing pipes to which the sprinkler "heads" are attached shall be fixed at intervals of 8 to 10 feet along the ceiling of each room. In textile factories one sprinkler head protects 100 superficial feet of floor area; and a pressure of 10 lb. per square inch has to be maintained at the highest sprinkler of the installation. Allowing for bends, contractions in the pipes, and friction, this requirement means that a pressure of from 80 to 100 lb. per square inch has to be maintained in the rising main. This may be effected by direct connection to the public supply, or to a tank on the top of the building, or by a pump. This latter can readily be arranged to start working automatically, its action being ingeniously controlled by the pressure of the water in the pipes themselves. The capacities of the tanks—which should be so placed that the bottom is 15 feet above the highest sprinkler head—are as follows:—

For not more than 150 Sprinklers on one floor, 5,000 gallons.

For not more than 200 Sprinklers on one floor, 6,500 gallons.

For more than 200 Sprinklers on one floor, 7,500 gallons.

HAND FIRE EXTINGUISHERS.

Function.—That of serving as a safeguard in addition to sprinklers and similar appliances—to be used by workpeople at the critical moment of an outbreak.

Description.—Usually made to hold from $2\frac{1}{2}$ to 3 gallons of fire-annihilating fluid, which can be thrown a distance of about 30 yards. The chamber of the apparatus is filled to within a few inches of the top with bi-carbonate of soda in solution. Inside the chamber, secured to the cover, is a glass bottle containing sulphuric acid, hermetically sealed. This bottle is surrounded by a perforated protector of sufficient strength to resist the action of the chemicals. Above the bottle, and in connection therewith, is a plunger, provided with a button, which on being struck smartly by the key (hung on the outside of the chamber) breaks the bottle, and allows the contents to mix with the soda solution. There is thus produced carbonic acid gas, which is retained in the chamber under a pressure of about 130 lb. per square inch. The contents are discharged at will through a rubber tube attached to the chamber, which tube, being flexible, can be directed to any desired part of the room. In recharging this apparatus the cap is removed by the aid of the screw-key mentioned, and the chamber is refilled with soda solution; a fresh bottle of acid is inserted, and the cap is screwed on, whereupon it is ready for action again in time of need.

Fire-resisting Doors.—Usually made of two or three thicknesses of well-planed timber, placed at right angles to each other, and the whole covered with small sheets of tinned steel, put on without solder. The tinned steel armour, while free to expand, practically excludes the air. Thus, in case of fire, there is not sufficient air underneath the plates to support combustion, beyond a preliminary charring of the wood by contact with the red hot plates; and after this stage the charcoal itself forms an additional protecting cover, which still further retards the combustion. In cotton mills these doors usually close by sliding, and should be weighted so as to close automatically. All sliding or hinged fire-

resisting doors should exceed the net width of the brick opening by at least three inches all round; doors warp considerably during a fire, and this margin somewhat counteracts the bad effect. Trap doors should be similar to upright doors, and have a fusible link attachment to close them automatically in case of fire.

Iron Fire Escapes.—In England the law compels employers of labour to provide reliable means of escape in case of fire in all places where over forty people are employed. Appliances for the purpose should be self-contained, and provided with cast-iron brackets, by means of which they can be secured to the building wall with wrought-iron bolts. The back pillars should be secured to these brackets, so that in the event of a panic there would be no danger of the rails giving way.

Safety Lighting-up Lamp. — Constructed on the principle of the "Davy" safety lamp, with wire gauze protector. The oil lamp is carried on a suitable supporting handle, and the only way gas can be ignited is through a tube with which the lamp is provided, and which is placed over the gas burner.

WATER POWER DRIVING

USEFUL MEMORANDA FOR HYDRAULIC INSTALLATIONS.

1 Foot = 12 inches = .305 metres.

1 Cubic foot of water = 6.24 gallons (say $6\frac{1}{4}$ gallons) = 28.3 litres = .0283 cubic metres.

1 Cubic foot of water weighs 62.5 lb.

1 Metre = 39.37 inches = 3.28 feet.

1 Cubic metre of water = 1,000 litres = 1,000 kilos. = 35.32 cubic feet = 220 gallons.

1 Cubic metre of water weighs about $1\frac{1}{2}$ per cent. less than 1 ton.

1 Litre of water = .001 cubic metres = .035 cubic feet = .22 gallons.

1 Litre of water weighs 1 kilogram = 2.204 lb.

Litres per second × 2.12 = cubic feet per minute.

Cubic feet per minute × .472 = litres per second.

1 Gallon of water = .16 cubic feet = 4.543 litres.

1 Gallon of water weighs 10 lb.

Pressure in lb. per square inch = head of water in feet × .433.

Pressure in lb. per square inch × 2.31 = the corresponding head of water due to such pressure in feet.

When water is flowing through a pipe at 3 feet per second, the quantity delivered per minute = approximately the diameter of pipe in inches squared.

1 Horse-power = 33,000 foot lb. per minute = 550 foot lb. per second.

1 French horse-power = 75 kilogrammetres (the weight of 75 litres of water falling 1 metre) per second = 542.5 foot lb per second.

To Ascertain the Horse-power, where Q = cubic feet per minute, and F = fall in feet:

$$\frac{Q \times F}{706} = \text{H.P.}$$

To Ascertain the Quantity of Water required for a given power:—

$$\frac{\text{H.P.} \times 706}{F} = \text{Quantity in Cubic Feet per minute.}$$

To Ascertain the Height of Fall in feet required to produce the H.P.:—

$$\frac{\text{H.P.} \times 706}{Q} = \text{Fall in Feet.}$$

1 French horse-power at 75 per cent. efficiency =

$$\frac{\text{Litres per second} \times \text{Fall in Metres.}}{100}$$

The foregoing figures are based upon 75 per cent. efficiency. For 80 per cent. efficiency take 660 as the constant, and for 70 per cent. efficiency take 754 instead of 706.

With a plentiful and constant supply of water, there are instances of the machines being driven by separate small water-turbines, neither belts, ropes, nor electric motors being required.

With such drives for Ring Frames the water supply may come from a reservoir with a fall of about 400 feet. The water from the main pipe is conducted through smaller ones down a channel under the main alley at the end of the frames, and with a junction to each frame the water enters the turbines. These latter are constructed to develop the required power and to run at about 900 revolutions per minute with a pressure of apout 170 lb. per square inch. The speed is altered by increasing or reducing the water supply, as a guidance to which it is advisable to have a tachometer attached to each tin-roller shaft.

In the Blowing Room and Card Room turbines of larger dimensions are employed, and the driving is from line shafts by either belts or ropes, as in electric driving.

GAS POWER

The gas engine is now in use in sizes up to 5,000 horse-power units. It is an economical prime mover, and has now established itself as a commercial success. Many steam-engine builders are now taking up the construction of large gas engines.

Economy.—With gas-engine driving the economy in fuel is much greater than with the steam engine. Taking an average figure, it is estimated that 1 H.P. can be generated at one-half the fuel cost of that which is required for the steam engine, which is an important item in sizes of about 1,500 H.P. and upwards. A further saving can be effected by the recovery of ammonia by-products, which in some cases amount in value to almost that of the coal itself.

Gas producers are made to use (and are working successfully) with such fuels as peat, wood, sawdust, lignite, waste coke, cotton seeds, etc.; as also, of course, to coal itself.

Peat Gas.—When peat is used in the place of coal, the blocks of peat after having been dried are placed within a feeding hopper at the top of the plant, from which they pass into a generator, where gasification of the fuel takes place by means of partial combustion. Crude gas is formed, which is quite as rich as the gas obtained from the Welsh anthracite coal; and by means of an exhauster fan it is drawn off, cooled, and purified. All the tar products are removed, and the clean gas is passed into a gas-holder. It is then passed on to the engines used for developing the necessary power to drive the looms in the factory.

Installation.—The complete installation of a gas-driving plant is self-contained. It consists of the generator, which takes the place of the steam boiler, and the engine proper. The space taken is about equal to that occupied by the boiler. There is no chimney required, nor reservoir for condensation.

Labour.—About the same as that required for a steam plant, but the work is much lighter.

Up-keep.—Considerably less than a steam plant.

Steadiness of Running.—Is assured by the improvements recently made therein.

Exhaust Gases.—The exhaust gases from the engine can be utilised to generate steam for heating and other purposes for which steam may be required. The apparatus used for raising the steam is also provided with a

fire-grate, so that steam may be generated when the engine is standing at the week-end, or when an extra supply is required during working hours.

Gas Producers.

Types.—Pressure Bituminous.
Suction Bituminous.
Suction Non-Bituminous.

Pressure Bituminous.—Uses ordinary steam coal, and consists of a producer through which air and steam are blown in the generation of the gas and a purifying apparatus. There are several types of the latter, but the simplest consists of a series of atmospheric coolers, through which the gas passes from the producer. The gas is cooled to atmospheric temperature, and at the same time deposits any tar, which latter is run away to a sump in the ground. The gas passes to a water washer, and forward into the gas-holder, through a sawdust drier. This plant is simple, and there are no duplicate parts to get out of order.

Suction Bituminous.—Also uses ordinary steam coal, except the kind that has a tendency to cake. In principle it is much the same as that of the pressure type, except that the gas-holder and blower are dispensed with. In this system the air and steam are drawn through the producer by the suction of the engine piston, or, when two-cycle engines are used, by the pump on the engine. By this latter method there is more regular suction and a greater power is obtained.

Suction Non-Bituminous.—Only uses such fuels as anthracite coal or coke. In other respects the principle involved is much the same as in the foregoing plants, except that the purifying apparatus is simpler, because there is no tar deposit to get rid of.

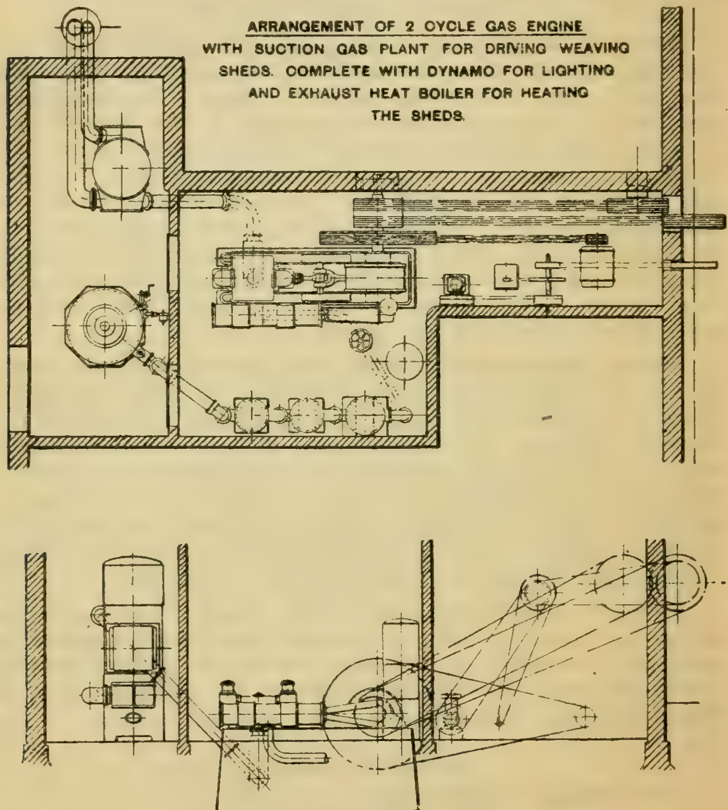
The Gas Engine.

Types.—Two-Cycle.
Four-Cycle.

Two-Cycle.—The action of the valve is the same as in a steam engine, and every stroke is a driving stroke. Each charge of gas is put into the cylinder by means of a separate pump, and enters therein under a few pounds pressure. The charge is further compressed in the main cylinder, as in the four-cycle engine. This

method reduces the strain on the engine, and having a large number of impulses per cylinder, it is enabled to run very steady.

Four-Cycle.—When worked on the double-acting principle, only each second stroke is a power stroke, because the piston must push out the burnt charge before a new supply can be sucked in the cylinder. In small



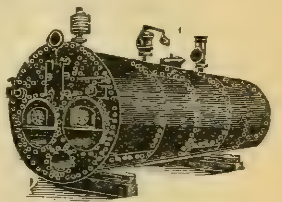
engines, where the principle is invariably single-acting, every fourth stroke only is a power stroke. This type of engine is usually fitted with a heavy fly-wheel to steady the running.

Some makers arrange the four-cycle single-acting cylinder vertically, and obtain a steady drive by multiplying the cylinders instead of using the fly-wheel.

BOILERS, ENGINES, SHAFTING

STEAM BOILERS.

There are two recognised types of shell or two-flued boilers used in the generation of steam for cotton mills—namely, the "Lancashire" and the "Yorkshire."



The "Lancashire" (or shell) **Boiler** is the type commonly used in generating steam for cotton mills, and the particulars given in the following pages have special reference thereto :—

Sizes and Pressures.—With the introduction of steel plates for the shells, and the use of machine-riveting, boilers of the Lancashire type are now made in sizes from 6 ft. 6 in. dia. by 20 ft. length, to 9 ft. dia. by 32 ft. length, and are capable of withstanding pressures of from 160 to 180 lb. per square inch.

The "Yorkshire" Boiler is a modification of the "Lancashire" in the following details :—It is shorter in proportion to its diameter, the ratio of length to diameter being as 5 is to 2. Its flues rise slightly from front to back, and expand from the end of the furnaces to the downtake in the proportion of 5 to 6; that is, the sectional area of the flues at the rear is about 33 per cent. greater than at the front. This has the effect of locating more water directly over the points where the larger proportion of heat is transmitted to the boiler than at any other part.

Mounting.—In mounting a boiler, it is advantageous to make the shape of the side flues follow as nearly as possible the curvature of the boiler. There is then less liability for the accumulation and deposit of soot about the plates.

Points:

A good disincrustant is common soda or soda-ash.

To remove deposit in boiler open blow-off tap occasionally.

From 18 to 20 lb. of water per foot of grate-space is the amount of evaporation of a good Lancashire boiler.

It is a wise precaution to lift safety valves slightly and test gauge cocks daily, to make sure that they are in working order.

Flues should be thoroughly swept periodically, the bridges and fire-bars being removed. Never remove the mid-feather wall from the down-take flue.

To burn 1 lb. of coal economically, 15 or 16 lb. of air are required, giving a surface temperature of about 3,000 degrees.

Care should be taken to avoid broad brickwork surfaces where dampness can lodge and lead to corrosion. Every part

of the boiler-plates should be accessible to the heated gases. Curvilinear blocks, giving the smallest possible point of contact with the boiler, are now available for mounting boilers.

To burn coal economically, the flue gases should contain about 16 per cent. of carbon dioxide. In actual practice, however, the gases often contain less than 5 per cent.

BOILER POWERS.—The following table supposes economisers, the use of ordinary COAL, and a reasonable DRAUGHT:—

Dia.	Length	Lb. water evaporated per hour.	A	B	C	D	E	F	G	H
ft. in. 6 6	ft. in. 20 0	3600	100	200	240	250	280	300	320	350
"	22 0	3850	100	200	250	280	300	320	340	370
"	24 0	4200	120	220	280	300	320	350	375	400
"	26 0	4540	130	230	300	330	350	380	400	430
7 0	24 0	4800	150	260	320	340	370	400	420	450
"	26 0	5200	160	280	340	370	400	430	450	490
"	28 0	5500	170	300	370	390	420	460	480	530
"	30 0	5900	180	320	400	420	450	490	500	570
7 6	26 0	5500	170	300	370	390	420	460	480	530
"	28 0	6000	180	330	400	430	460	500	510	590
"	30 0	6500	200	350	430	460	500	540	546	640
8 0	28 0	6500	200	350	430	460	500	540	546	640
"	30 0	7000	200	360	470	500	540	580	600	690
"	32 0	7500	220	400	500	530	570	610	630	720
8 6	30 0	7400	220	400	490	520	550	600	620	710
"	32 0	8000	250	430	520	540	590	630	660	750
9 0	30 0	8250	260	450	535	560	600	650	680	770
"	32 0	8700	270	470	560	590	640	680	700	800
			INDICATED HORSE-POWER.							

Boiler Powers.—References to foregoing table:—

A, B } Engines of different degrees of wastefulness.

C.—Good average modern compound engine, 100/140 lb., no superheat.

D { First-rate compound engine, 150 lb., no superheat. Good average modern compound engine, 100/140 lb., superheated.

E.—Exceptionally good compound engine, 160 lb., no superheat.

F.—First-rate triple-expansion engine, 180 lb., no superheat.

G, H { Exceptionally good compound or triple-expansion engines, 160 lb. to 200 lb. pressure, considerable superheat.

Additional allowance must be made for heating and steaming the mill, etc.

With an Induced Draught Fan it is often found practicable to add to the size of the Economiser, thus making for greater economy.

Mill Chimneys.—Where natural draught is depended upon, a height of 150 ft. for the chimney stack may be taken as the maximum necessary, provided the area of the flue has been properly proportioned. This latter should be pretty nearly in direct ratio to the combined areas of the boiler flues connecting with it.

Scientific Control in the Boiler Room.

There are now in use in a large number of mills throughout the country scientific recording apparatus of various kinds, designed to secure improved economy in the boiler-room without necessitating structural alterations.

Certain devices under this heading are Draught Gauges, and Draught Recorders, Water Meters, etc.

Combustion (CO_2) Recorders.—Give a continuous record of carbonic acid in the flue gases, which percentage is an indication of the completeness of combustion and of the excess of air allowed to enter the furnace.

Steam Pressure Recorder Gauge.—Indicates the steam prssure in the boiler at sight, and furnishes continuous diagrams showing the variations that have occurred during the day or night at the times of stoking, etc. This enables the stoker to regulate the draught so as to

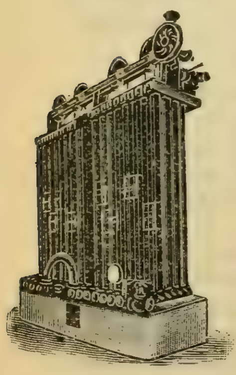
suit the conditions of the moment, and furnishes the engineer with a certain check upon the working of the fires.

Steam Meter and Recorder.—Determines and registers the weight of steam flowing through a pipe under almost any conditions. Is invaluable in cases where it is desired to charge the running costs of each section of a power plant exactly to its own particular department—especially where the steam used forms an important part of the prime cost of manufacturing an article, or where the steam raised is sold to a third party.

Water Gauge Glasses.—Gauge glasses are now made more distinguishable by a simple treatment of the glass by means of which the water is caused to assume a black appearance, while the steam space above shows a silvery appearance. The difference is so marked that a workman can see the water-level a considerable distance away.

ECONOMISERS.

Fuel Economisers are fitted to almost all cotton mill boilers. They are usually made with 4 to 10 pipes in a row, 8 being the most convenient number. These rows are arranged side by side to the required number. A 350 I.H.P. boiler would require 112 tubes or 14 rows of 8 tubes each.



In determining the extent of a boiler plant, decide upon what quantity of water the boiler must evaporate, and what class of coal is going to be consumed.

In determining the size of an Economiser plant, it is necessary to take into consideration the—

(1) Number, size, pressure, and evaporation per hour of boilers.

(2) Feed-water — hard or soft, and source of supply. Average temperature of same.

(3) Quantity and quality of fuel used.

(4) Temperature of gases in main flue or entering chimney.

An Economiser heating pipe (9 ft. long by 4 9-16th in. external diameter) holds approximately 60 lb. of water, and this quantity should take one hour to pass through from bottom to top to give good economy. Therefore, to find number of pipes required for any given

boiler evaporation, divide the number of lbs. of water evaporated in the boiler per hour by 60.

Rule for finding the amount of heating surface in square feet of any Economiser for Water Tube Boilers is as follows:—

For small boilers divide the heating surface of boiler by 2.
For large ,, ,, ,, by 3.

TO CALCULATE SIZE ON COAL CONSUMPTION.—Allow one pipe in Economiser for every 5 cwt. of coal consumed per ordinary working week of, say, 54 hours; or 4 pipes per ton.

TO CALCULATE SIZE ON THE INDICATED HORSE POWER.—Allow one pipe in Economiser for each 3 indicated horse power developed.

Each Economiser heating tube is taken as having 10 square feet of heating surface.

Power required to drive the scrapers.—½ H.P. should be allowed for every 96 tubes.

Every 10 degrees Fah. the feed-water is raised in temperature, which in the Economiser means a saving in fuel of 1 per cent., although the saving is greater from 100 degrees to 200 degrees than from 200 degrees to 300 degrees.

A 4	pipe wide Economiser takes up space	3 ft. 4 in.
A 6	,, ,, ,, ,,	4 ft. 8 in.
A 8	,, ,, ,, ,,	6 ft. 0 in.
A 10	,, ,, ,, ,,	7 ft. 4 in.
A 12	,, ,, ,, ,,	9 ft. 6 in.

If a passage is required at the back of Economiser for inspection and cleaning, 9 in. extra must be added to above sizes.

MECHANICAL STOKERS.

Function.—To increase the efficiency of steam boilers, to economise coal consumption, and to abolish smoke nuisance.

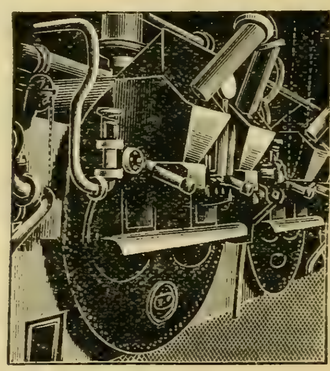
Types.

Coking Stokers.—In these the coal is pushed on to the furnace in a mass from the front of the boiler, and becomes partially coked before reaching the fire. It is practically smokeless, and is very effective for light loads, where there is ample boiler power and a regular steam demand.

When a compressed air furnace is used in connection with this stoker, the clinker and ash is carried over into a chamber between the back end of the bars and the bridge, from whence it is cleaned out at intervals.

Sprinkler Stoker.—In this type the coal is supplied to the furnace intermittently in very small quantities, each time on to a different part of the fire. The amount of coal is controlled by an adjustable cam on the driving shaft; this cam regulates the coal-feed from nothing to one ton per hour.

In conjunction with this stoker may be used, with advantage, a self-cleaning compressed air furnace, which consists of a series of tubular fire-bars extending over the whole length of the furnace. These are protected from direct contact with the fire by being covered with short interlocking grate-bars. The air is supplied to the furnace through tubular troughs, and can be regulated to suit the varying demands for steam from the boiler. All the fire-bars move forward together about



two inches and return singly, thereby bringing the fuel to the end of the furnace and dropping the ash over into the ash chamber. With this stoker cheap "breeze" or dust fuel can be used.

The efficiency of this stoker may be still further assisted by the use of an adjustable **shovel arm** arrangement. This consists of an arm with a pointed shovel provided with a tripper and lever attached to a rocking shaft working in a cross-head. The cross-head is operated by a piston working in a pneumatic cylinder, and the motive power propels the shovel forward, scattering the coal over the furnace.

A good sprinkler will burn up to 40 lb. slack coal per square foot of grate area with natural draught, increasing the efficiency of the boiler from 10 to 30 per cent.,

according to conditions, and at the same time maintaining a good average CO_2 record. Low-grade small slack unsuitable for hand-firing can be efficiently burned by using mechanical stokers.

Chain-grate Stoker.—This is specially adapted for water-tube boilers. The coal is fed over the whole width of the grate, and the depth of the fire can be adjusted to meet the varying demands for steam. Seals are provided at the sides of the grate to prevent excessive influx of air at these points. A high degree of efficiency is obtained in water-tube boilers by the aid of this type of stoker.

Elevators and Conveyors.—These labour-saving appliances can be used to convey coal direct from canal barge or railway truck to the boiler furnace at a minimum cost. They are also of service in dye and print works, warehouses, etc., for conveying loose material from one place to another.

Generally speaking, elevators are classed as of the "belt" or the "chain" type. The former consist of plants in which an endless leather, cotton, rubber, or canvas belt is used to carry the elevating buckets. In the latter case an endless detachable chain (single or double strand) takes the place of a belt, and the buckets, arms, or other elevating supports are bolted thereto. Conveyors are usually formed as bands, trays, lattices, or coupled carriages, according to circumstances. The choice of method will depend upon the nature of the work to be undertaken, and is in any case best left to the experience of the manufacturer or expert.

Oil as Fuel.—When oil is used as a substitute for coal, it is necessary to cover the entire surface of the boiler furnace bars with ashes or clinkers, to a depth of about four inches. The barrel or tank containing the oil is placed in any convenient position, a connection is made therewith, and the oil inlet branch of a conduit is made by ½ or ¾ inch piping, according to requirements. A similar connection is made between a steam supply and a steam inlet branch. The oil and the steam unite at a junction, and the pressure of the latter acts as ejector and discharges the oil, in the form of a heated spray, evenly over the bed of ashes. Two valves serve to regulate the supply of steam and oil respectively, and a centre one acts as a further check to the supply of oil to the furnace.

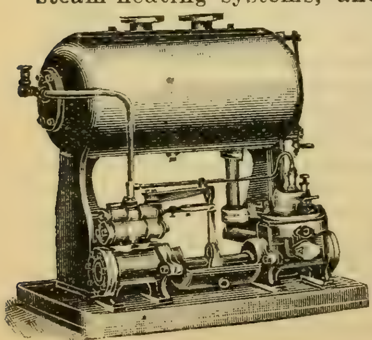
SMOKE PREVENTION.

There are two kinds of smoke, one of which is preventable, while the other is unavoidable. Preventable smoke, the discharge of which is so objectionable, is black smoke or unburnt carbon; and by the application of proper means this can be consumed—to the advantage of the public and to the profit of the coal consumer. Perfect combustion can be obtained only by an efficient supply of oxygen to the fuel under proper conditions. This is sometimes made more difficult by firms extending their productive plant without due regard to the productive capacity of their boilers—with the result that heavy firing is resorted to, and a contravention of the bye-laws takes place in respect to the emission of black smoke. In this regard it may be well to recall Section 91 of the Public Health Act (Great Britain) of 1875, which declares that any chimney sending forth black smoke in such a quantity as to be a nuisance shall be deemed a nuisance liable to be dealt with summarily in the manner provided by the Act. And further, that all furnaces and fireplaces must be constructed in such a manner as to consume, as far as practicable, the combustibles used therein, having regard to the practice or process of manufacture.

In addition to the use of mechanical stokers as a means for preventing black smoke, there are other appliances available, which possess varying degrees of merit. These are chiefly in the form of regulators for controlling the inlet of air to the furnace, and the working of the dampers in the boiler flues

STEAM CONDENSATION.

Receiver. — Collects the water of condensation from steam-heating systems, and generally enables same to be used again. When collected at high temperatures, a great saving may be effected in coal consumption. This water is in the best possible condition for boiler-feeding, owing to its temperature and its purity.



Description. — Is usually made to work in conjunction with a pump, and is provided with controlling mechanism to regulate the steam supply to the pump, as the water

rises or falls in a receiver into which the condensation runs. A float-and-lever arrangement controls the steam valve.

Production.—Made in three sizes, to deal with 500, 1,000, and 1,500 gallons of condensation per hour, respectively, at 50 lb. pressure or over.

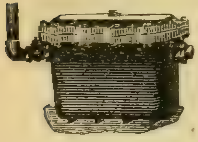
STEAM TRAPS.—For taking away the water of condensation, and allowing only dry steam to pass on to the point of action. To do its work efficiently an apparatus should not fail to remove the condensation from all parts, and should also work automatically and without waste of steam.

Ball System:—The trap usually consists of a copper ball having a small hole at the bottom, and a down pipe, which is connected by an elbow pipe to a hollow screwed spindle. At the end of this is fixed a loose valve, which is alternately forced to its seat and released by the falling and rising of a ball float which rotates with the screwed spindle. When the ball falls to the bottom of the trap the loose valve separates from the seating, whereupon the condensed water flows through the hollow spindle and elbow pipe into the ball, and then up the pipe and through an outlet. As long as the ball contains condensed water it remains down, but the entrance of steam forces any water present up the pipe and through the outlet. When the ball becomes buoyant its action closes the valve.

Bucket System:—In which a bucket floats in water contained in a tank, and condensed steam enters the trap inlet by gravitation and overflows into the open bucket. As the bucket fills its increased weight causes it to sink in the tank, and by so doing to draw a spindle in the centre downwards. This opens a valve, and allows the water to escape along a channel formed in the tank. Immediately the water is discharged, the bucket again rises and closes the valve, for the operation to be repeated.

An improved type of Bucket Trap is now made, in which the bucket controls only a small relay valve, and the steam pressure within the trap opens and closes the main valve. Thus the relay valve—which is actuated by the bucket in the ordinary way—need only be very small, and the bucket need have little work to do—whereas the

main valve may be any size, to facilitate the flushing of the water from the trap.



Syphon System:—The part to be drained is connected to a union. The trap is first filled with water and the lid secured. Steam is then turned on, and the water of condensation flows freely through an open valve and out by the syphon. As soon as the steam arrives and the pressure tends to accumulate in the trap, the water is forced up the syphon, at which time the ball follows the water down and partially closes the valve. In practice the ball finds a position where it will pass all the condensation water, *plus* sufficient steam to fill the box. The valve never really closes; the ball acts as a weight only.

Dirt Catcher.—Function: To prevent sediment, grit, or dirt from entering steam traps and injuring the valves and seatings. Is usually fixed between the steam main and the trap. The drain connection leading to the trap should be fitted to the under-side of the steam pipe to be drained.

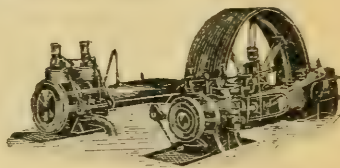
Water Cooling. — Devices for water-cooling may be adopted with advantage by steam-users having condensers the water supply of which is limited, or is obtained from towns' mains at considerable cost. They effect great economy by making it possible to use the water over and over again. In addition to the recognised methods of cooling water in ponds and by means of sprayers, resort may be had to cooling-towers of special design and construction. These latter not only take up considerably less ground area than do ponds, but they are more effective for the purpose.

Boiler Incrustation.—Common soda is very largely used to prevent "scale" forming inside boilers. The soda should be free from impurities; the most reliable quality is that known in the alkali trade as "58 per cent. ammonia soda." When a boiler has been emptied and refilled, add so much of the soda to the water as will make it slightly alkaline—that is, just to turn red litmus paper blue.

Grease Separator.—Removes oil or grease from boiler feed-water before condensation, by deflecting the steam downwards over the surface of accumulated water, and reducing the velocity by passing it through passages having a large area. These passages are formed by an

oil-collecting device, which consists of a series of corrugated iron plates placed side by side. The plates have wings partly punched out of them, in such a manner as to present torn edges against which the current of steam impinges. The particles of entrained grease adhere to these edges, and flow down the corrugations into a collecting chamber.

THE STEAM ENGINE.



Output.—The question of output from a certain number of machines is largely dependent upon the engine that produces motive power to drive them.

Most Economical Load for Condensing Steam Engines.—The tables on the following pages give coefficients or multipliers, corresponding to different cylinders and pressures. By simply picking out the coefficient corresponding to a given low pressure, cylinder diameter, and the boiler pressure, and multiplying the piston-speed of the engine by this coefficient, the most economical load for that engine is found.

Engine Indicators.—Diagrams obtained by these instruments shew whether the valves of an engine are correctly and evenly timed. They serve as a guide for adjusting the valves in order to get the best distribution of steam within the cylinder. They shew the power developed in the cylinder, and indicate any loss that may arise from leakage, back pressure, or incorrect adjustment of valves. They shew whether the steam ports and passages are of the right size, and indicate the condition of the valves and pistons. The indicator can also be used to test the influence of the feed-water upon the economical working of an engine.

In addition to its use in connection with steam engines, the indicator is serviceable in measuring and recording all pressures that are liable to variation.

COST OF MILL DRIVING BY STEAM.

A Spinning Mill

Example.—A Lancashire mill, containing about 100,000 mule spindles, with preparing machinery, spinning twist and weft of medium counts. The engines, which are of the horizontal compound type, are 1,400 indicated horse-

power, and work with a boiler pressure of 160 lb., superheated to 550 deg. The high-pressure cylinder is 26 inches in diameter, and the low-pressure cylinder 56 inches. The stroke is 5 feet, and the speed 63 revolutions per minute. The fly-wheel is constructed for rope-driving, and the power is transmitted to the different rooms of the mill through a convenient rope race. The engine is fitted with "drop" valves, and the steam inlet for the high-pressure cylinder is automatically regulated by a governor of recent design.

The average working of these engines over a period of several months shews the coal consumption to be 59 tons in 55½ hours, producing 1,431 indicated horse-power—or at the rate of 1.66 lb. of coal per horse-power per hour. The price of the coal consumed was given at 9s. 3d. per ton, making a sum total per 55½ hours of £27 5s. 9d. The above figures include the steam consumed in warming the mill and other incidental purposes.

A Weaving Shed.

Example.—Cost of Driving and Heating a modern Lancashire Weaving Mill containing close upon 1,700 looms, with the usual Winding, Warping, and Sizing Machinery :—

The period of working was the year 1911, and the engines driving the mill are of the horizontal cross-compound type, with high and low pressure cylinders, 20 inches and 40 inches diameter respectively, 4 ft. 6 in. stroke, making 63 revolutions per minute. Fly-wheel 20 ft. diameter, transmitting the power through 22 ropes 1⅝ inches diameter :—

Total revolutions of engine during year 1911 = 11,183,786, of which 4,696,956 were at 68 per minute, and 6,486,830 were at 68½ per minute.

Total working for the year = 2,730 hours. Mean load for the year, from 50 indications taken at varying times, and after deducting the piston rods, was 711 I.H.P.

The heaviest or winter load was 748.5 I.H.P., which was recorded on October 3 at 7 a.m., and on the same day at 4-40 p.m. the engine indicated 704 I.H.P. The lowest indication was taken on Wednesday, June 7, at 11 a.m., and shewed 661 I.H.P.

The average winter load was 2.25 looms per I.H.P., and in the summer 2.55 looms per I.H.P. Average for the year 2.37 looms.

SUMMARY OF COSTS.

Total—	
Fuel costs delivered in boiler-house	£1,052 11 6
Engine-room costs	256 10 0
Boiler-house costs	100 8 3
Cost of production of 711 I.H.P. through 2,730 hours	£1,409 9 9
Total—	
Fuel cost per hour for 1,686 looms, including taping	£0 7 8½
Engine-room costs	0 1 10½
Boiler-house costs	0 0 9
	£0 10 4
Average—	
Cost per I.H.P. through 2,730 hours has been	£1 19 7¾
Cost per loom through 2,730 hours has been	0 17 6½

SHAFTING.

The safe and satisfactory load for shafting depends greatly upon circumstances, and is a subject upon which there is a variety of opinions.

For tables shewing the powers that can be satisfactorily put on to shafting see "The Cotton Year Book" for 1913, pages 478 and 479.

Textile machinery is constantly increasing in weight; —not that spindles are running heavier, but they are grouped in larger units. Accordingly, the shafting of a modern mill must be stiff and well made. It is not sufficient that shafting shall be put in just so strong that it will not twist off; if it is to be really satisfactory, it should be up to the standard of the List, so that it shall run well at high speeds, be rigid when machines reverse or go suddenly off and on, and give no trouble with its couplings. These are the weak links in the chain, and, together with every belt pulley, they will hold the faster for being on a larger shaft. For this reason it is not safe to assume that a steel shaft will drive more than one of wrought-iron. It would, if there were no couplings; but not otherwise.

ENGINE POWERS (Condensing).

Showing the Indicated Horse Power that should give the *greatest Economy* with given L.P. Cylinder and Boiler Pressure.

L. P. Cylinder Dia.	BOILER PRESSURES.														
	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
20 in.	·218	·236	·245	·251	·26	·264	·273	·28	·283	·286	·292	·298	302	·303	·312
21 in.	·241	·26	·27	·277	·286	·292	·3	·308	·312	·315	·322	·33	·332	·34	·344
22 in.	·264	·285	·296	·305	·314	·32	·33	·338	·343	·346	·355	362	·365	374	·376
23 in.	·289	·312	·325	·333	·342	·35	·36	·37	·374	·377	·386	·394	398	406	·41
24 in.	·314	·34	·354	·362	·374	·38	·391	·403	·406	·41	42	·43	·435	·443	·447
25 in	·34	·368	·384	·393	·405	·412	·428	·437	·441	·446	456	465	·47	·48	485
26 in.	·368	·398	·414	·425	·44	·445	·462	·472	·476	·485	·493	505	51	·52	525
27 in.	·397	·43	·446	·457	·472	·48	·496	·508	·512	·52	·53	542	548	56	·565
28 in.	·428	·461	·48	·492	·508	·518	532	·548	·552	·56	·57	582	59	·602	·61
29 in.	·46	·495	·515	·528	·542	·552	·572	·588	·592	·6	·612	·625	·632	·648	·652
30 in.	·49	·53	·55	·565	·58	·592	·612	·628	·634	·642	656	·67	·677	·692	·7
31 in	·525	·568	·59	·604	·624	·632	·658	·672	·68	·685	7	716	·725	·74	·748
32 in.	.56	·602	·625	·64	·662	·672	·7	·715	·725	·73	·745	·762	·77	788	·795
33 in.	·593	·642	·665	·688	·705	·718	·742	·76	·77	·78	·792	·812	·82	·838	·848
34 in.	·63	·68	·707	·725	·748	·76	·79	·808	·815	·824	842	863	·87	·89	·9
35 in	·67	·72	·75	·77	·795	·81	·838	·86	·866	·872	·895	·915	·922	·942	952

EXAMPLE :—Engine 15 and 27 in. cylinders, × 3 ft. 6 in. stroke, 77 revs., 120 lb. boiler pressure, = 539 × ·496 = 267 I.H.P.

Take the number corresponding to your L.P. Cylinder diameter and your Boiler Pressure, and with it multiply your Piston Speed. The result is the best load in I.H.P.

ENGINE POWERS.—*Continued.*

L.P. Cylinder Dia.	BOILER PRESSURES.														
	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
36 in.	·705	·76	·79	·81	·84	·854	·882	·903	·914	·922	·942	·965	·975	·992	1
37 in.	·748	·81	·84	·86	·88	·902	·938	·96	·97	·98	1	1·02	1·03	1·05	1·07
38 in.	·788	·85	·885	·908	·94	·95	·985	1·01	1·02	1·03	1·05	1·08	1·09	1·11	1·13
39 in.	·83	·895	·935	·955	·985	1·01	1·04	1·06	1·08	1·09	1·11	1·13	1·15	1·17	1·18
40 in	·87	·94	·98	1	1·03	1·05	1·09	1·12	1·13	1·14	1·16	1·19	1·2	1·23	1·24
41 in.	·92	·99	1·03	1·06	1·09	1·11	1·15	1·18	1·19	1·2	1·23	1·26	1·27	1·3	1·31
42 in.	·965	1·04	1·08	1·11	1·14	1·16	1·2	1·24	1·25	1·26	1·29	1·32	1·33	1·36	1·37
43 in	1	1·085	1·13	1·16	1·2	1·22	1·26	1·28	1·3	1·32	1·35	1·37	1·39	1·42	1·44
44 in	1·06	1·14	1·185	1·22	1·25	1·28	1·32	1·35	1·365	1·38	1·41	1·44	1·46	1·49	1·5
45 in	1·11	1·19	1·24	1·27	1·31	1·34	1·38	1·42	1·44	1·45	1·48	1·51	1·53	1·56	1·58
46 in.	1·16	1·25	1·3	1·33	1·38	1·4	1·45	1·48	1·5	1·52	1·55	1·58	1·6	1·64	1·65
47 in	1.21	1·3	1·35	1·39	1·43	1·46	1·5	1·54	1·56	1·58	1·61	1·65	1·67	1·7	1·72
48 in	1·26	1·36	1·41	1·45	1·49	1·52	1·58	1·61	1·63	1·64	1·68	1·72	1·74	1·77	1·79
49 in	1·31	1·42	1·47	1·51	1·56	1·59	1·64	1·68	1·7	1·72	1·76	1·79	1·81	1·85	1·87
50 in.	1·365	1·47	1·53	1·57	1·62	1·65	1·71	1·75	1·77	1·79	1·83	1·85	1·89	1·93	1·95
51 in	1·42	1·53	1·58	1·63	1·68	1·71	1·78	1·81	1·83	1·85	1·9	1·94	1·96	2	2·02
52 in	1·48	1·59	1.66	1·7	1·75	1·78	1·85	1·89	1·91	1·93	1·98	·02	2·04	2·08	2·1
53 in,	1·54	1·67	1·72	1·77	1·82	1·86	1·92	1·96	1·98	2·02	2·05	2·1	2·12	2·16	2·18

EXAMPLE:—Engine 25in. and 48in. cylinders, × 5ft. stroke, 62 revs., 160 lb. boiler pressure, – 620 × 1·68 = 1041·6 I.H.P.

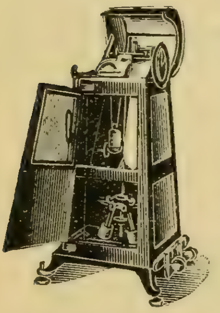
Take the number corresponding to your L.P. Cylinder diameter and your Boiler Pressure, and with it multiply your Piston Speed. The result is the best load in I.H.P.

It is not desirable that shafting under 3 in. should be used to drive mules of 1,000 spindles, and that no shaft under $3\frac{1}{4}$ in. dia. should run as high a speed as 400 revs. per minute with 11 ft. bays.

Solid Muff Couplings.—Couplings now made of this type dispense with the usual keys and keyways. They are secured to the shaft by the means of wedge-shaped bolts, which when tightened-up exert a strong grip upon the shaft. The bolts are practically enclosed, so that the periphery of the coupling may, if necessary, be used as a belt pulley.

Guard for Line Shafting.—For preventing accidents to workhands when oiling and otherwise dealing with the bearings, etc., of driving shafts. Consists of a tube of compressed paper or other suitable material, made in halves for mounting upon the shaft, and bound into cylindrical form by metallic clips or straps, the bore of the tube being slightly larger than the diameter of the shaft passing through it.

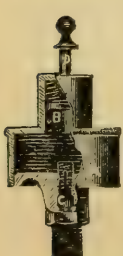
Speed and Pressure Recorders.



Function.—To give a permanent record of every momentary variation in the speed of an engine, and of the pressure of steam in the boilers, together with the times of starting and stopping. The records are marked in diagrammatical form on strips of paper, which may be removed daily or weekly for entry into a book usually kept for the purpose. By the aid of these recorders, a system of regularity is ensured without the manager or overlooker having to keep a constant watch over the engineer in charge.

Fixing.—Usually on the engine crank shaft.

Speed.— From 84 to 92 revolutions per minute.



Shaft Lubricators.—For applying lubricant to shafting automatically and continuously. They are worked by a screw-pressing action, which forces the lubricant into the bearing, while a delicate spring continues the feed after the screw-pressure ceases.

Sight-Feed Lubricators.—Usually consist of a chamber, containing the oil, into which is inserted a bent tube.

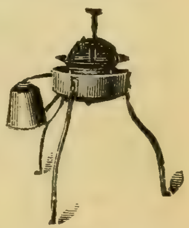
Through this tube the oil is drawn and discharged into a sight-feed glass by the creation of a vacuum in the cavity therein. This is obtained by the outward movement of a ram, which on returning forces the oil through a check-valve to the part to be lubricated.

LUBRICATING OILS.

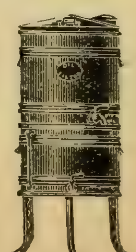
In ascertaining the lubricating quality of oil, the following constants should be observed :—

The specific gravity (best taken by means of a bottle); vapourising temperature; flash and fire tests (these may be found either by means of an open cup or by Gray's flash point apparatus); proportion of free acid; and the viscosity of the oil and the influence of heat upon it. This latter constant is the most important. An oil with a high viscosity is not suited for lubricating spindles, while, on the other hand, oil with a low degree of viscosity will not do for shafting and engine bearings.

Oils act variously under the influence of heat. Some lose what viscosity they had and become limpid, being then unsuited for working at high temperatures. The viscosity of oil should therefore be determined at various temperatures, so as to ascertain the influence of heat on the oil. For oils used in lubricating spindles, looms, and shafting, viscosities may be taken at 70 deg., 100 deg., and 120 deg. F. The tests may be made on "Viscometer," which works on the principle of observing the time in seconds that a measured quantity of oil takes to flow out of a narrow tube, or on testing machines.



Waste Oil Filter.—Separates and filters oil that has already been used, and purifies it sufficiently for second application. The oil to be filtered is poured into an upper chamber, which is in the form of a sieve, whence it drains through a pad into a dish-shaped chamber. The oil then passes through a second pad into water, and works its way through a third pad into a chamber surrounding it. Here the oil floats on the top of the water, and eventually overflows down a tube into a second water tank. Ascending through another pad, the oil again floats and overflows down a second tube into a water tank at the bottom of the apparatus. The oil then ascends in a

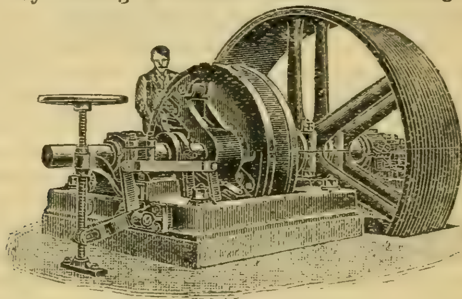


clarified state, and is drawn off at will through an ordinary discharge tap.

FRICTION CLUTCHES.

By judicious adoption, friction clutches can be used with great advantage in cotton mills, bleach and dye works, etc.

In cotton mills each line shaft may be stopped independently by fixing a clutch at the driving end of the shaft.



Dynamos may be driven direct from an engine, and through friction clutches may be started and stopped at will and without shock. Where gas, oil, or other combustion engines are used, clutches are a necessity to enable them to start well with the full load on.

Clutches are made in a variety of forms, and may be moved in and out of gear by lever, fork, or other suitable appliance. They prevent accidents which are liable to occur when moving belts or ropes from fast to loose pulleys.

USEFUL MAXIMS to be observed in the Engine and Boiler Houses:—

1.—Where coal is cheap, extreme "economy" sometimes costs more than it is worth.

2.—Friction not only costs money for coal and oil, but it uses the extra power in wearing out your plant.

3.—There is more virtue in two extra bolts to a pipe-joint than in all the patent joining material on earth.

4.—A permanent difference in price is a permanent difference in quality.

5.—Spur and bevel wheels are articles of consumption.

6.—Dirt is the prophet of the break-down.

7.—The man who experiments with his plant is a benefactor to his competitors.

8.—You may not want spare air-pump valves, but if you do, you will want them badly.

9.—A broken crank-pin step will run for years, if it can see a spare one in the engine house ready to take its place. If not, it won't.

10.—A small air-leak in your injection-pipe will add 5 per cent. to your coal bill; and it is very bad to get at, so lay them carefully.

11.—Check the pressure gauges on your boilers by an indicator; they are almost sure to be wrong.

12.—Spare catch-plates, buffer springs, etc., should be fitted into their place and then stored; otherwise they won't go in when they are wanted and the mill will stand.

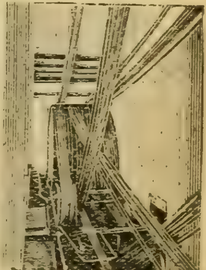
13.—Cast-iron pillars out of doors frequently contain water. If holes are drilled at the bottom they can't; so they don't burst in a frost.

14.—Engines on coal-fields should be levelled up periodically. The cost is small, and the evidence, in case of subsidence, priceless.

15.—If your engine is not fittted with a vacuum breaker and steam cut-off, for top and bottom governor-positions, it is not safe.

In the first of the foregoing maxims it is stated that, when coal is cheap, extreme "economy" costs more than it is worth. That is to say there are cases where an extra two or three hundred pounds, or even more, is invested to get a shade lower steam consumption on a trial,—although the result, taking a month's run of the mill, shows that the saving in coal due to the extra elaboration does not pay good interest and depreciation on the extra cost. Manufacturers should watch this point, taking into account the price they pay for their coal, and particularly satisfying themselves that the extra elaboration does not in any way increase the risks of stoppage: for if it stop the mill for one extra day in the year, it may easily wipe out the whole of the saving that it was put in to effect. The cost of stoppages should be debited to its proper place—that is, to the cause of the stoppage.

ROPE DRIVING



The most favoured system of transmitting power from the steam engine or other motor, to the various line shafts of a cotton mill, is that of rope-driving. Ropes are less costly than either gearing or belts; are clean, noiseless in operation, and occupy little space sideways. With a multiplicity of ropes there is little inconvenience from breakdowns, and repairs can be executed quickly.

Fast and Loose Rope Pulleys.—By a combination of fast and loose sheaves power may be transmitted from the line shaft to the machines of a cotton mill. The arrangement consists in providing a shallow inter-

Powers that ropes will transmit under favourable conditions:—

Smallest Pulley	Diam. of Rope	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100
		ROPE SPEEDS IN FEET PER MINUTE.																
33 in.	1 in.	8	8	9	9	10	10	10	11	11	11	12	12	12	13	13	13	13
42 in.	$1\frac{1}{4}$ in.	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21
48 in.	$1\frac{1}{2}$ in.	19	19	20	21	22	22	23	24	25	25	26	27	28	28	29	30	31
57 in.	$1\frac{3}{4}$ in.	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

HORSE POWERS.*

Smallest Pulley	Diam. of Rope	4200	4300	4400	4500	4600	4700	4800	4900	5000	5100	5200	5300	5400	5500	5600	5700	
		ROPE SPEEDS IN FEET PER MINUTE.																
33 in.	1 in.	14	14	14	15	15	15	16	16	16	17	17	17	18	18	18	19	
42 in.	$1\frac{1}{4}$ in.	21	22	22	23	23	24	25	25	26	26	27	27	28	28	29	30	
48 in.	$1\frac{1}{2}$ in.	31	32	33	34	34	35	36	37	37	38	39	39	40	41	42	43	
57 in.	$1\frac{3}{4}$ in.	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	

HORSE POWERS.*

* **These powers are based on the assumption that one or both of the rope pulleys are as small in diam. as those shown in the first columns of the above Tables. If the smallest pulley used is larger than these sizes, then the power given in the list corresponding to the diam. of the rope and the rope speed should be increased in proportion.** That is, take the power from the Table, multiply it by the diam. in inches of the smallest pulley actually used, and divide by the diam. in inches of the pulley given above.

Example;—$1\frac{1}{2}$ in. rope running 4,500, smallest pulley 48 in., power 34 horse power,
$1\frac{1}{2}$ in. " " " 56 in., " $\frac{34 \times 56}{48}$ = 40 horse power nearly.

mediate groove in one side of the fast pulley in addition to the grooves ordinarily provided. In starting the machine and as the rope is transferred from the loose to the fast pulley, it passes into the shallow groove mentioned, and thus gains a revolution before entering upon its work. The system works very successfully in driving ring frames.

HINTS TO USERS.

In designing a rope drive, take care to have the pulleys large enough, and to have a margin of rope power.

Pulleys.—These should not be less than 30 times the diameter of the rope used. Pulleys that are too small, quickly break up the ropes. Moreover, they reduce the power the ropes will transmit.

Speeds. — When the pulleys are reasonably large, 4,800 feet per minute is a good speed for ropes driving the line shafts of a cotton mill. Speeds above 5,000 are not economical, as far as the durability of the ropes is concerned.

Grooves.—For ropes exceeding 1 in. dia., the grooves should have an angle of 40 degrees, and for smaller ropes, 30 degrees.

Carrier Pulleys.—The grooves should allow the rope to rest well in the bottom, and have flanges at an angle of about 10 degrees.

Cross Driving.—Arrange the ropes in pairs, crossing one rope to the left hand, the other to the right hand, so that the tight sides of both run next to each other. Between each pair of ropes there should be a spare groove in the pulleys. The pulleys should be as near as possible of the same diameter. If one is much larger than the other, the crossing occurs nearest the small pulley, and the ropes are then liable to chafe against each other.

Drive Out of Parallel.—The grooves should be of such depth as to measure from $1\frac{1}{2}$ to 2 in. diameter at the opening.

Angular Drive, with Guide Pulleys.—The tight side of the ropes should be guided to its position by the pulley resting at an angle, while the pulley having the horizontal axis guides the trailing span. This rule holds good whether the pulleys are on the same plane or above or below each other.

Vertical Driving.—Allow a little extra for power, and do not have the grooves at an angle of more than 30 degrees.

Vertical Half-Cross.—Have the centres as far apart as possible, and plenty of room for adjusting the pulleys on the shafts.

Slipping of the ropes may arise from the following causes:—(1) Insufficient gripping force on the pulley. (2) Overloaded drives. (3) Slack ropes.

Clearance.—In splicing ropes a little clearance should be given, as the ropes cannot be spliced on the pulleys, but must be put thereon afterwards.

"**Sagging.**"—Allowance for "sagging" should be made both on the slack and tight sides of the ropes. When starting or stopping an engine the "sag" often runs momentarily to the side opposite that where it is usual, and it is important to avoid contact with obstructions during this short period. The amount of sag depends upon the tension of the ropes, the load, and the length of the drive; but it is good practice to allow 8 per cent. of the distance between the centres of the shafts.

———

Ropes should not rub against anything on their flight.

Two sizes of ropes should not run together on the same drive, unless both pulleys are of the same diameter: otherwise uneven driving will result.

Points:—

Ropes diminish slightly in diameter with wear, and when new should exceed by $\frac{1}{8}$ inch the groove tney are actually made for.

Ropes run best if treated occasionally with a little anti-fraying composition. Blacklead mixtures should not be used.

Never put water on ropes to tighten them: its effect is only temporary, and the rope eventually stretches worse than ever.

To Ascertain the Length of a Rope.—Centre to Centre of shaft $\times$ 2 + half circumference of each pulley.

———

Rope Splicing Tool.—This is a device useful for mill-owners who do not engage a man from the maker's to splice and fix their driving ropes. It is made with a hollow head, in which the strand of rope that is being tucked can be inserted. It is a more convenient tool than the sailors' marline-spike or "fid."

BELT DRIVING

Belt or Strap Driving, whether by means of leather belts or woven or other materials, is a convenient method of transmitting power.

It is almost universally employed in the case of driving each separate machine in textile and other factories, because of the great convenience of using fast and loose pulleys, by means of which each machine can be stopped or set in motion while the driving shaft is running.

A belt transmits its motion entirely by frictional contact with the surface of the driving and driven pulley.

Increase of power can always be obtained by increasing the size of the pulleys, which gives a larger frictional area. Where possible the sag of the strap ought always to be on the top side, so as to increase the area of the lap and give a larger and tighter grip.

The coefficient of friction between cast-iron pulleys or drums with leather belts is about 0.45 when the belt is tight on the pulley. The friction is greater on wood pulleys, as also on pulleys lagged on the surface or covered with paper or other material.

The power that can be transmitted by a belt depends on the thickness and width of the belt, the size of the pulley, and the speed at which the belt travels. The maximum strength of good leather is about 3,500 lb. per square inch of section.

There is no advantage in running belts above 4,000 feet per minute, as the centrifugal force then becomes excessive.

The speed of a strap per minute can always be found by multiplying the circumference of the pulley on which it works (in feet) by the speed or revolutions of the shaft per minute. If the pulley is small, the circumference in inches may be multiplied by the revolutions per minute, and then divided by 12 to give the feet.

The thickness of leather belts is usually from $\frac{3}{16}$ to $\frac{1}{4}$ inch, but compound belts may be made of as many thicknesses as required.

Woven belts of cotton or other fibres can be made of any width or thickness required. Leather belts also are formed by linking pieces of leather together by steel rods; they have great flexibility and yield good results, but when first used the initial stretching is considerable.

Leather belts must not be used in damp places. Woven belts have the advantage of being made of any length and width in one piece, and can now be obtained of much greater strength than leather belts of the same thickness, and can be made so as to be unaffected by water, steam, chemical fumes, etc.

In making out calculations of speeds, etc., when driving by belting, allow from 1 to 2 per cent. for loss in "creep" or "slip."

Rules.—To find the horse-power any given belt will transmit—

Multiply the width of the belt in inches by 45 if single belt and by 75 if double; then by the speed of the belt in feet per minute; next divide by 33,000, and this will give the horse-power.

Example.—What power will a single belt 10 inches wide and running at 1,200 feet per minute drive?

$$\frac{10 \times 45 \times 1{,}200}{33{,}000} = 16{\cdot}36 \text{ H.P.}$$

For double belting—

$$\frac{10 \times 75 \times 1{,}200}{33{,}000} = 27{\cdot}27 \text{ H.P.}$$

To find the width of belt necessary to drive any given horse-power—

Multiply the power to be driven by 33,000, and divide by 45 for single belt and 75 for double belt, multiplied by the speed of the belt in feet per minute. This will give the width of belt in inches.

Example.—What width of belt is necessary to drive 50 horse-power when the belt runs at 2,200 feet per minute?

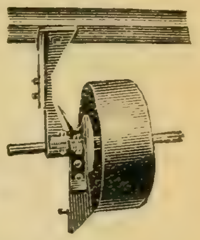
$$\frac{50 \times 33{,}000}{45 \times 2{,}200} = 16{\cdot}6 \text{ inches for Single Belt.}$$

$$\frac{50 \times 33{,}000}{75 \times 2{,}200} = 10 \text{ inches for Double Belt.}$$

Pulleys.—For belt-driving it is advisable to use as large pulleys as convenient and the nearer the ratio between the driver and the driven pulley the better. Belts on large pulleys have a greater efficiency than on small ones; on narrower ones (consistent with necessary strength) than on wider ones; and on long drives than on short ones.

Where clutches are not employed on the pulleys of line shafts, it is better to use mounters for getting the belts on the pulleys than to do the work by hand.

Belt Mounter.—A preventive device against accidents when putting straps upon large driving pulleys.



Consists of a two-part cast-iron bush, embracing the shaft with sufficient clearance, and fixed by means of a bracket to the ceiling or wall of the building. Adjoining this bracket is a two-part revolving piece which serves as the belt catcher. This piece is provided with a disc to prevent the belt from falling into the nave of the pulley. On the opposite side is a fork, which actually catches the belt. To prevent the belt from being hurled about, a pawl carried by a bush is rotated in the opposite direction of the pulley, for the purpose of preventing the revolving piece being carried along with the belt. Opposite the fork a wooden piece is fixed on the belt catcher, which is cut to a suitable angle according to the width of the belt. Into this piece of wood a metal pin is secured. To put the belt on, the pawl is disengaged, and by means of a fork attached to a wooden handle of suitable length, the revolving piece is turned round in the direction of the rotation of the pulley, whereby the belt slips off the slanting wood and is caught by the pulley. The same handle also serves for disengaging the pawl before the mounting is done, and for throwing it in before the belt is taken down. This mounter can be used for pulleys up to about 6 feet diameter and belts 12 inches wide.

Other appliances of a simpler kind than the above are available, in which the mounter follows the belt round the pulley, until it releases itself and can be removed without danger to the operator.

Belts ought always to be of sufficient width and strength to transmit the power without straining. The rules above give these for any given power.

The use of good belt "dressing" will give better driving and keep the belts in good order so that they last longer.

Steel Belting.—For use in place of gearing, leather belts, and ropes, in the transmission of power from the prime mover to the respective line shafts. The system consists in the use of a flexible steel belt running over pulleys covered with layers of canvas and cork. The belt is of hardened charcoal steel, prepared by a special

process, rough rolled at a red heat, and then brought down to a thickness of about 1/64th of an inch and to any width from 1½ to 8 inches. The tensile strength of the finished material is given at about 95 tons per square inch.

CHAIN-DRIVING.

Chain-driving is positive, and requires no tension to make the chains grip their sockets. The system requires little space in which to work, and it can be adopted with great advantage in cramped and awkward positions. It gives efficient service at centre distances too short for belts and too long for gearing. Owing to recent improvements in construction, chains can be used for almost every kind of drive, but several considerations determine the best size and type of chain to be used, among which are:—(1) The nature of the drive. (2) Whether the load is steady or fluctuating. (3) The speed required. (4) The power to be transmitted.

Types.—There are three recognised types of chain in general use:—

(1) "Silent" High-speed Chain.
(2) Roller Chain.
(3) Block Chain.

Speed.—No hard-and-fast rule can be laid down as to speed for any particular drive; but with the first-named type (the "Silent High-speed") a speed of 1,300 feet per minute is regularly attained. The "Roller" type is generally used for speeds up to 800 ft. per min., and the "Block" chain for very slow speeds, and for conveying and elevator work.

Chain Durability.—It is seldom that a driving chain is not strong enough for the work it has to do, and it will invariably work out of pitch with the wheel teeth before it breaks. Such a size of chain as will postpone this condition as long as possible should be selected. The life really depends on the amount of pressure per square inch of wearing surface (*i.e.*, on the rivet bearings), and this is, of course, also influenced by their hardness and finish. As the wearing surface and the strength of a chain are both governed by the rivet diameter, it is customary to select a chain by its strength instead of by calculating the rivet-bearing surface. To obtain a suffi-

ciently durable chain, the ratio between the pull and the breaking load should be, for—"Silent" chain, 1—30; for "Roller," 1—20; and for "Block," 1—15. The factor varies to some extent with the speed: for instance, with the "Silent" chain a factor of (say) 20 would be sufficient for good conditions and a speed of only 500 feet per minute, while for carrier work in the "Block" chain the factor has been taken as low as 5. A chain well above its work is more enonomical than one rather below; therefore it is advisable to use a larger factor in severe cases where the load is irregular or impulsive. For such drives the use of a "spring sprocket" is recommended, in which springs are interposed between the rim and the boss of the wheel. This absorbs the fluctuations of the load and prevents their injuring the chain; and for irregular drives from electric motor the use of a spring wheel has a very beneficial effect on the motor in preventing "flatting" of the commutator.

Sprockets and Ratios.—The highest ratios desirable between driver and driven sprockets are: for—"Silent" chain, 1—6; for "Roller" chain, 1—7½; and for "Block" chain, 1—7½. The maximum and minimum number of teeth advisable are—"Silent," 17 and 110; "Roller," 8 and 80; and "Block," 6 and 60. An odd or "hunting" tooth is an advantage on the pinion for "Silent" chain, and sprockets of good size are to be preferred, as they are less severe on the chain than small ones, and they tend to give a quieter drive.

Position of Drive.—Inclined or horizontal positions with the *tight side* of the chain *on the top* are preferable; and where possible the larger sprocket should be uppermost, so that the weight of the chain is distributed over a good number of teeth.

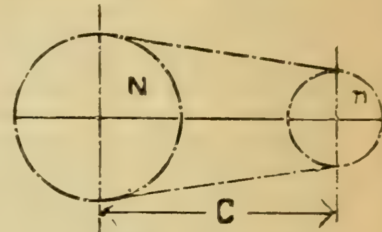
Centre Distance.—Where possible, this should not be less than 50 pitches of the chain, nor greater than from 10 to 12 feet for heavy "Silent" chain drives. For elevator and carrier chains which run on supports the centre distance may be almost any length.

With equal wheels it is a simple matter to reckon the number of pitches in a chain, but for unequal wheels the accompanying formula is given. In order that the chain may be kept at a right tension, the centres should be adjustable. "Jockeys" should never be used for the "Silent" chain unless they can be arranged to gear properly with the chain, having at least three teeth in gear; and where necessary for "Roller" and "Block"

chains should be toothed wheels and should be used on the slack side.

$$\text{Chain Length in Pitches} = 2C + \frac{N}{2} + \frac{n}{2} + \frac{\left(\frac{N-n}{2\pi}\right)^2}{C}$$

C = Centre distance in pitches.
N = No. of teeth in large wheel.
n = No. of teeth in small wheel.

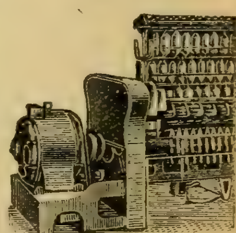


Erection.—Where possible, shaft bearings should be rigid, and sprockets should run absolutely true, and be mounted near a bearing if on light shafts liable to spring under load. Greater exactitude in alignment is advisable than with belts; and if the drive is from an electric motor, the end play of the armature should be kept at a minimum. Alignment is not of such vital importance as with "double helical" cut gears.

Lubrication.—Ordinary chain drives should be lubricated once a week, with a lubricant of good quality and free from any tendency to gum. For high speeds use a thin oil in order to penetrate the joints, and follow up with a thicker oil that will not be thrown off by the centrifugal force. The lubricant is best applied with a brush to the inner side of the chain while running slowly.

ELECTRICAL DRIVING

Where electricity is used for driving, power can be transmitted to any point without the use of shafting. Full advantage should be taken of this fact when deciding on the position and duty of each motor in a mill, so that the maximum economy may be obtained. The power wasted in turning shafting, with its pulleys and belts, is practically independent of the power it is transmitting: so, as the conditions in a mill change in course of time, it is often possible to effect further economies by so rearranging the motors that shafting need never be run "light"—as it often must be in a mechanically driven mill when only some of the machinery is in use.



Generally speaking, it is not advisable to drive each machine throughout the mill by a separate motor. Doing so undoubtedly reduces to a minimum the transmission losses referred to above; but, on the other hand, very small motors are not themselves so efficient as larger ones, and their initial cost is relatively high. Ring frames for spinning and doubling are the chief exceptions to this generalisation, as in their case considerable advantage can be gained by driving each individually (see note on page 135). Other exceptions are those of the earlier preparation machines—such as bale breakers, etc.—which are not in continuous use, and heavy calico-printing machinery, which requires repeated starting and stopping.

The majority of the other machines are best driven from short line-shafts, to which motors mounted for the purpose on the wall or ceiling are directly coupled. In grouping the machines care should be taken not to have all of one sort driven by one motor. For instance, in the **card room** of even a small mill there should be at least two line-shafts, each driving some of the carding engines, draw frames, combers, and each class of fly frame in use. In this way the maximum economy is attained, in that when less preparation is required one motor and line shaft can be stopped without interfering with the work of the other; also the maximum reliability, in that trouble to one motor or shaft will not disorganise the work of the whole room.

On account of the heavy fluctuations in the power taken by a pair of **mules** it is always advisable to drive them in groups of at least two (and preferably more) pairs, so that the total load on the motor is more nearly steady.

It is rarely advisable to drive calico and other light **looms** from individual motors, as but little power is required for each. For these, the motors are best coupled to each line-shaft with not fewer than fifty looms on each.

The foregoing remarks on mules apply also to heavy jacquard looms.

Horse-power of Machines.—The approximate power required by each machine will be found among the notes on it in this handbook. The power is, of course, dependent on the length and capacity; therefore, when electrical driving is to be adopted, it is always advisable to ascertain from the makers of the machine the power which they estimate it will require.

Horse-power of Motors.—The power of motors is almost invariably stated by the makers in terms of the "brake" horse-power (B.H.P.)—which means the actual horse-power they can deliver to the shaft continuously without overheating. Motors are usually designed to have a temperature rise at full load of not more than 70 deg. F. above the surrounding atmosphere. To measure the temperature of a motor, a thermometer should be inserted as far as possible into the interior, and it is essential that the bulb should be in actual contact with the windings and the iron around them. As a rule, a motor is not dangerously hot if the temperature of the windings and iron inside it does not exceed 200 deg. F. as measured by the thermometer. Tests should only be taken after the motor has been running some hours at the desired load.

Supply.—Older installations are mostly designed for "direct" current, as that was the first to come into general use. Practically all modern installations, however, are for three-phase "alternating" current, as the advance of knowledge and experience has shown it to be preferable both as regards transmission and the motors themselves.

Maintenance of Motors.—The insulation on the windings of motors consists principally of cotton, coated or impregnated with either shellac varnish or some special preparation of a similar nature. Damp and dirt, especially in the form of oil, are highly injurious to the insulation. For this reason motors should never be placed in positions exposed to the weather, and should be kept as clean as possible.

The best type of motor for use in a mill is one which is totally enclosed from the room in which it stands, and which ventilates itself through air channels, with cool, clean air drawn from outside the mill. A motor of this description requires the minimum of attention, as neither dirt nor oil can accumulate in it.

Motors of the ordinary open or semi-enclosed type should be wiped down once a week, as much "fly" as possible being picked out of them.

The commutators and brush gear of direct-current motors should be very carefully wiped over and cleaned every week, and the brushes renewed when necessary. Should the commutator become blackened, or should continuous sparking appear at the brushes, the commutator should be cleaned over with fine glass-paper

(0 or 00). This should only be done when absolutely necessary. No attempt should be made to keep the commutator *bright*, as the most satisfactory results are obtained when it has turned a dark colour and has been polished by the ordinary friction of the brushes.

All motors working on the floor of a mill, as distinct from those suspended on the wall or ceiling, should be taken to pieces once a year, and the insides thoroughly cleaned of the dust that has accumulated in them.

Oiling.—The great majority of electric motors are ring lubricated. The oil wells in the bearings of these contain sufficient oil to suffice for several weeks' work, the actual consumption of oil being exceedingly small. The oil wells should be drained and refilled about once in three months. Care should be taken *not to overfill* the wells, as any oil overflowing from them aids the accumulation of fly and dirt.

Fuses.—The chief duty of fuses is to cut off the current in the event of a fault developing in the motor. Before removing fuses (for inspection or renewal) it is very advisable (in the interests of personal safety) to make the fuse contacts "dead" by withdrawing the main switch, and it is absolutely necessary to do so if the pressure is more than 250 volts. Where a number of fuses are arranged on one board, particular care should be taken to remove only the right one, as a dangerous arc may be produced by withdrawing a fuse while it is carrying current. Fuses carried in porcelain bridges or tubes are the best type for circuits up to about 20 amperes; for heavier currents totally enclosed fuses (as of the "Mordey" type) should be used.

For motors which start "light" and work on a practically uniform load, it is sufficient to provide fuses to blow at 1½ times the full-load current. For motors which have to start against load or are subject to periodical overloads, the fuses should be capable of carrying about twice full-load current.

For small currents tin wires are most convenient, but for larger currents copper wires must be used, as heavy tin or lead wires have a tendency to run. Fuses may be made up of any number of strands of wire, the number and gauge depending on the current to be carried. In making up a fuse the strands should not be twisted together, but spread out to allow air to circulate between them; otherwise they will fuse at less than the calculated current. Copper wire fuses that are not

totally enclosed should be inspected every month and renewed when necessary, as they deteriorate and become brittle when kept continuously hot, and are then unreliable.

Standard wire gauge.	Copper wire fuses at	Tin wire.
32	11.5	1.84
30	14.2	2.27
28	18.4	2.96
26	24.7	3.97
24	33.4	5 36
22	48.0	7.69
20	70.0	11.20
18	108.0	17.30
16	166.0	26.60
14	232.0	37.20

Alloys of tin and lead fuse at slightly lower currents than pure tin.

DIRECT-CURRENT MOTORS: CALCULATIONS.

The **full-load current** of a direct-current motor can be found from the rated horse-power and the pressure. Thus—

$$\text{Full Load Current} = \frac{\text{horse-power} \times 746}{\text{volts} \times \text{efficiency}}$$

746 are number of watts of electricity which are equivalent to a mechanical horse-power.

The efficiency depends on the size of the motor, but for the purposes of this calculation a fair average efficiency is 90 per cent.

Example.—What is the full-load current of a 7-H.P. D.C. motor working on a 110-volt circuit?

$$\text{Full Load Current} = \frac{7 \times 746}{110 \times 0·9} = 52·7 \text{ amperes.}$$

The **approximate load** on a direct-current motor can be found from the current and pressure. Thus—

$$\text{Approx. Load in Brake Horse-power} = \frac{\text{amps.} \times \text{volts} \times \text{efficiency}}{746}$$

Where the motor is not fully loaded the efficiency may be taken as 88 per cent. for this calculation.

Example.—A D.C. motor working on a 230-volt supply is taking 85 amperes. What is the load?

$$\text{Approx. Load} = \frac{85 \times 230 \times 0{\cdot}88}{746} = 23 \text{ B.H.P.}$$

In a **THREE-PHASE** Circuit—

The *pressure* (or voltage) is the number of volts between any two of the three wires.

The *current* is always understood to be the current per phase. In a "balanced" three-phase circuit the current in all three phases (and therefore in all three wires) is equal.

The *frequency* (or periodicity) is the frequency of the changes in direction of the current, and is always stated as the "number of cycles per second" (a cycle being two complete reversals). The most common frequency is 50 cycles (per second), which means that the current changes the direction of flow (*i.e.*, alternates) 100 times a second. Forty-cycle supplies are also much used in England.

The *watts* are calculated by multiplying the product of the amperes and volts by 1.73 (the factor for three-phase work) and the power-factor. Thus—

$$\text{Watts} = \text{Amps.} \times \text{Volts} \times 1.73 \times \text{Power-factor.}$$

The power-factor for a mixed power and lighting load is generally between 0.8 and 0.85; for a power load only (or when very little lighting is used) it is often below 0.8, and sometimes below 0.7 when the motors are not fully loaded.

THREE-PHASE MOTORS: CALCULATIONS.

The **full-load current** of a three-phase motor can be found from the rated horse-power and the pressure. Thus—

$$\text{Full Load Current} = \frac{\text{horse-power} \times 746}{\text{volts} \times \text{efficiency} \times \text{power-factor} \times 1{\cdot}73}$$

The actual efficiency and power-factor both depend on the output and speed of the motor, but for the purposes of this calculation they may be taken as 90 per cent. and 0.85 respectively.

Example.—What will be the full-load current of a 100-B.H.P. motor working on a 500-volt three-phase circuit?

$$\text{Full Load Current} = \frac{100 \times 746}{500 \times 0{\cdot}9 \times 0{\cdot}85} = 112{\cdot}2 \text{ amperes.}$$

The **approximate load** on a three-phase motor can be found from the current and pressure. Thus—

$$\text{Approx. Load in B.H.P.} = \frac{\text{current} \times \text{volts} \times \text{effic.} \times \text{power-factor} \times 1{\cdot}73}{746}$$

For this approximate calculation the efficiency and power-factor may be taken as 88 per cent. and 0.8 respectively, if the motor is not fully loaded.

Example.—The current taken by a motor on a 440-volt three-phase circuit is 70 amperes. What is the approximate load on it?

$$\text{Approx. Load} = \frac{70 \times 440 \times 0{\cdot}88 \times 0{\cdot}8 \times 1{\cdot}73}{746} = 50{\cdot}5 \text{ B.H.P.}$$

LAMPS.—Where these are used on **three-phase circuits,** care should be taken to balance the currents by distributing them equally between the phases.

As the pressures most common for three-phase circuits are from 400 to 500 volts, it is usually necessary to run two or more lamps in series on each phase. To avoid this, lamps are sometimes connected between each wire and the neutral point of the generator windings, from which a fourth wire is run. The pressure from each phase to the neutral point is $1/\sqrt{3}$ (that is, 0.58) of the pressure per phase. Thus if the pressure per phase is 400 volts, 230 lamps may be used singly in this way.

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WIRE TABLE.—Opposite is a list of the standard cables most commonly in use, with the maximum current which each may safely carry. If there is no cable corresponding exactly to the full-load current to be carried, use the next size *larger*.

Wire Gauge.	Max. Current (1,000 amps./□")
3/22s	1.86
7/22s	4.34
7/20s	7.14
7/18s	12.7
7/16s	22.5
19/18s	34.4
19/17s	46.7
19/16s	61.2
19/15s	77.3
19/14s	95.6
19/13s	126
19/12s	161
37/14s	186
37/13s	246
37/12s	314

MILL STRUCTURAL WORK

Concrete is a good fire-resisting material when properly mixed. The chief point of importance is the selection of a suitable aggregate. Concrete in which limestone is used for the aggregate is disintegrated, crumbles, and loses cohesion, when subject to fierce fires. Concretes of gravel or sandstone also suffer, but in a less degree, and require to be renewed after a fire. Suitable aggregates for fire-resisting concrete are those which have already passed through fire or are porous, such as furnace clinker, clean coke breeze, broken stone, and pumice. Care must be exercised in selecting aggregates. Coke breeze and slag contain sulphur, and if this be present in too large quantities it has a deleterious influence on the Portland cement, causing cracks and other defects. A great point in favour of concrete is that it expands almost equally with steel, and, owing to the natural affinity or bond of the two materials, it does not readily admit of the expansion of the steel-work; besides which, its thermal conductivity is not great.

Reinforced Concrete.

Concrete in its original form is weak in tension (though strong in compression), and this defect has limited its use to the making of foundations for mill and works engines, and for similar purposes. It has, however, lately been found that by the introduction of steel, in the form of bars or network, concrete can be strengthened to such a degree that, if correctly proportioned, the united strength of the two materials exceeds many times the sum of their individual strengths. The reason is attributed to the introduction of the second material, which converts an inelastic body into one possessing elasticity. The compound thus produced also embodies the additional element of increased durability.

Reinforced concrete can be obtained either in the form of slabs or in bulk. Its tensional strength is such that it can be used for mills' and works' floors, requiring no further support beyond the ordinary pillars and girders. It has a breaking strain of about 40 tons to the square inch. It is also serviceable for culverts, water conduits, etc. Coke breeze concrete is unsuitable as an aggregate for reinforced concrete; it is porous, and allows of the penetration of moisture with acids, breaking up the concrete and deteriorating the reinforcement. It should be mixed with broken brick, etc., to counteract the porosity; small granite chippings (to pass a

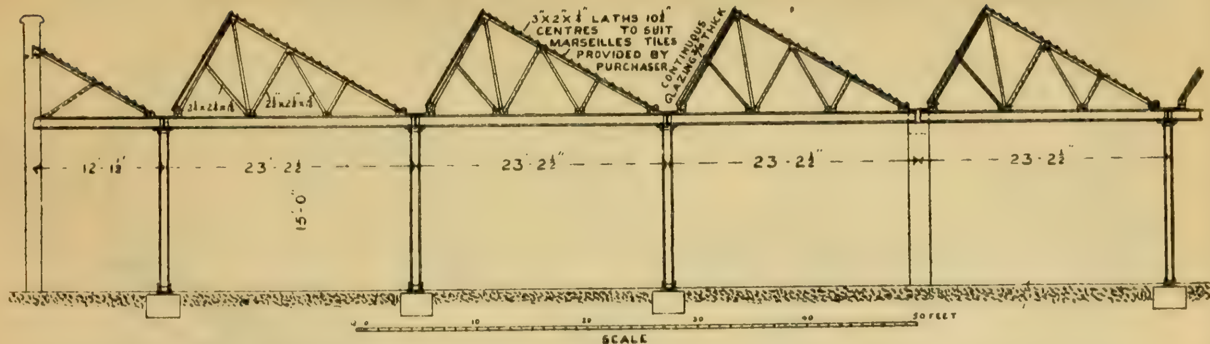
three-quarter-inch sieve) are, however, most generally used for the aggregate in this class of work.

Reinforced Brickwork.—Consists in using galvanised annealed steel wire meshing, which is obtainable in widths of 2 inches and 2½ inches, and in rolls of 25 yards each. The mesh of the fabric is hexagonal, and is strengthened by four straight wires, which run lengthways, two of which constitute the selvedge. In applying the meshing to a brick wall, it is rolled out along a horizontal mortar joint. The mortar keys itself in and over the wires, and a mechanical bond is thus formed, the combined strength of the two constituting a sort of reinforced beam. As each successive layer is thus treated the wall becomes strengthened to a remarkable degree. By thus converting several layers of brickwork into a beam the structure can be made to carry itself and a load over openings or bad ground, without any other support. The strength of the brickwork can be further increased by applying the network transversely as well as longitudinally.

By this method of reinforcement much thinner walls can be used. For instance, a 9-inch reinforced outside wall, made up of 4½-inch outside, 1½-inch space, and 3-inch brick on edge inside, can be substituted for one very much thicker when constructed of solid brickwork. For inside walls 4½ inches reinforced can be substituted for a 9-inch ordinary brickwork, and for partition walls the use of the wire makes a 3-inch brick on edge sufficiently strong. The system is equally serviceable for the outer walls of boiler seatings.

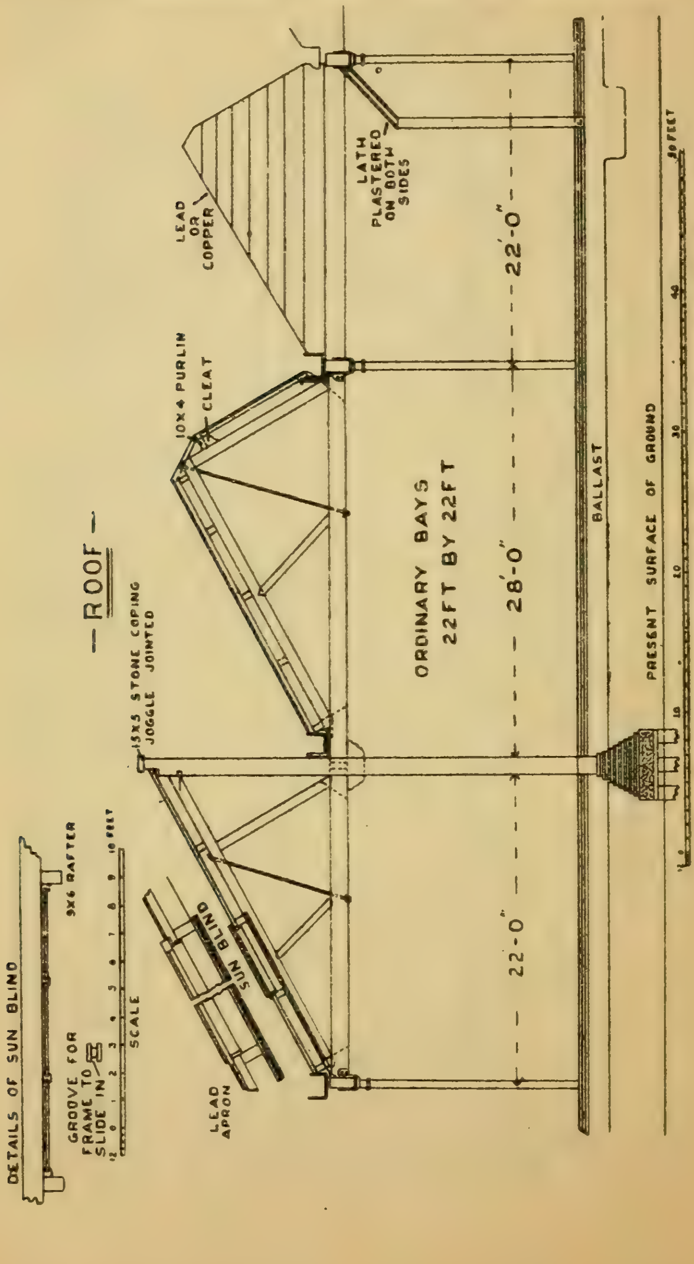
Rock Asphalt.—Is a natural rock, which can be melted by heat and in that condition be laid and spread as a covering for floors, walls, and roofs. By its use the flat roofs of spinning mills can be made water-tight, and when thus protected several inches of water may be left on the roof the year round, to assist in the maintenance of an equable temperature in the top rooms of the mill. The mixing, blowing, and card room floors, when covered with this material, present a jointless surface that will resist hard wear. In weaving sheds, bleach houses, and workshop, the material can be used with advantage in repairing broken and worn joints in the flagged floors. When applied in this capacity the edges of the flags are roughly hewn out with a chisel, and the asphalt, while hot, is spread level with the flags. It will then stand any amount of trolley traffic.

DETAILS OF MILL STRUCTURAL WORK.

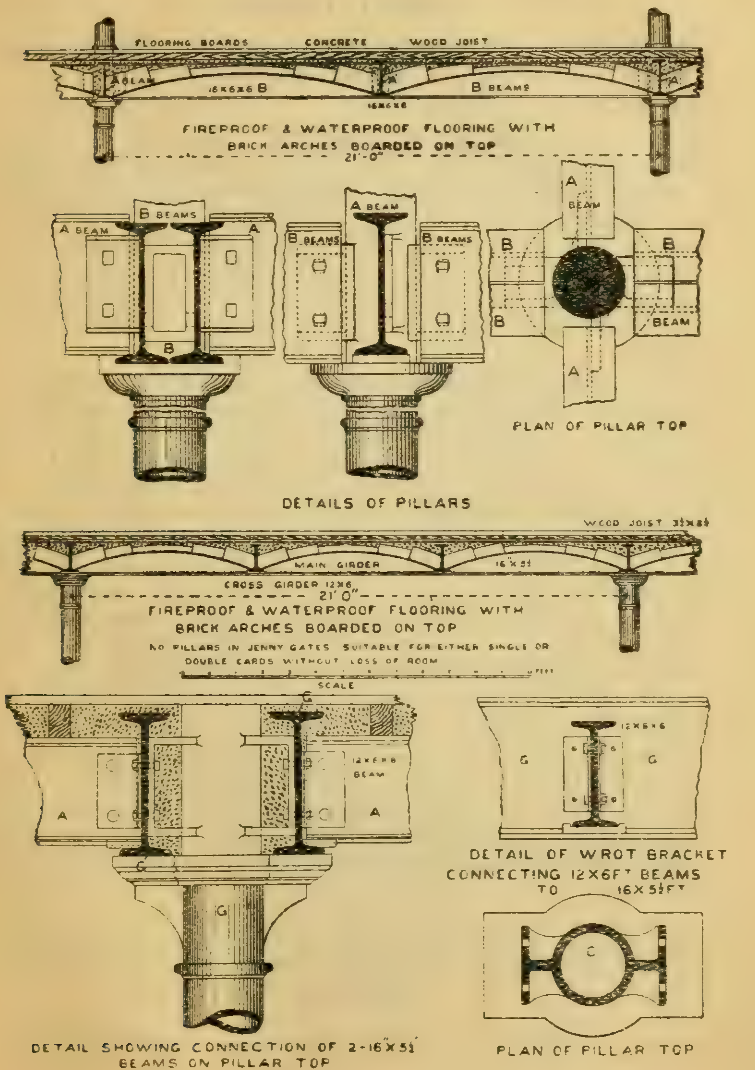


DETAILS OF ROOF FOR A SHED BUILDING.

IN building a weaving shed the lights should face the north, and the glass should be at an angle of not more than 30 degrees to the vertical. The average height should not be less than 14 feet 6 inches, and the height of the valley gutters from the floor not less than 12 feet. The boiler-house and the engine-house should be separated by an alley, and the flues from the boiler should not pass under the shed.



Details of Roof for a Shed Building.



Sections of Fireproof and Waterproof Flooring, with Brick Arches and Boarded Top, for Cotton Spinning Mill.

HOIST GATES.

Should be self-locking, and capable of being opened only when the cage is opposite the floor.

Types:—

(1) **With Hinged Doors.**—The doors can be opened only from the inside, and this is done by releasing a bolt or catch. The doors are again locked while open, and remain secure as long as the cage is at this level; but in the event of the cage being moved away, either up or down, the doors are released, and thereby close automatically by means of springs. As soon as closed, the doors are again locked by the bolt or catch mentioned.

(2) **With Collapsible Gate.**—The gate travels on a fixed bar across the top of the hoist-opening. The end bar of the gate is secured to the mill wall, and a second one carries a small pulley, which transmits motion to the gate, as the result of contact with the front face of a plate or cam attached to one side of the cage. A lock, which is fixed to the wall of the hoist well, engages with the end of a short sliding bar. The other end of this bar is attached to the gate at the same point as the cam pulley. In this position the gate is held shut until the cage arrives at the opening, at which period the rear face of the cam depresses a bolt projecting from the action box. This causes the slide bar to be unlocked, and allows the gate to be opened.

On starting the cage the cam pulley is driven forward by the cam, thus closing the gate until the slide bar is fully extended. Thereupon the lock falls into engagement with the rear end of it, and prevents the gate from being opened until the cage returns to the opening.

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☛ SEE also pp. 537-543: "Accidents: Preventive Measures."

SECTION XI.

ASSOCIATIONS

OF

EMPLOYERS AND OPERATIVES

HOLIDAYS

IN THE COTTON DISTRICTS

ASSOCIATIONS AND SOCIETIES
(Other than Trade-Unions)
CONNECTED WITH THE COTTON TRADE

Accrington and District Master Cotton Spinners and Manufacturers' Association, 12, Darwen Street, Blackburn.—John Taylor, Secretary.

Ashton and District Cotton Employers' Association, 3, Market Avenue, Ashton-under-Lyne. G. W. Fielding, Secretary.

Blackburn and District Cotton Employers' Association, 12, Darwen Street, Blackburn.—John Taylor, Secretary.

Blackburn and District Managers' Mutual Association.—Sec., George Knowles, Oak Cottage, Infirmary Road

Bleachers and Dyers' Mutual Indemnity Co., Ltd.—F. B. Knott, sec., 2, Cooper Street.

Bolton and District Cotton Manufacturers' Association, 23, Acresfield, Bolton.—John Dewsnap and John Taylor, Joint Secs.

Bolton and District Managers, Carders, and Overlookers' Association.—Mr. John Almond, Secretary, 59, Gibraltar Street. Meetings at Pack Horse Hotel, alternate Fridays. Also branch at Old Boar's Head Hotel, Bury, meet alternate Saturdays.

Bolton and District Managers and Overlookers' Association, The Institute, Henry Street, Bolton.—Wilfred Chatburn, sec., 46, Greenland Road. Fortnightly Meetings, Saturdays.

Bolton and District Master Cotton Spinners' Association, 23, Acresfield, Bolton.—A. Hill, Secretary.

British Association of Managers of Textile Works, 53, Corporation Street, Manchester.—Arthur Pollitt, President; Wm. T. Boothman, Past-President; W. Greenwood, Wm. Myers, M.Sc.Tech., and S. Watson, Vice-Presidents; Joseph Hurst, solicitor, Secretary. Meetings at the Victoria Hotel, Manchester, Tuesdays and Saturdays.

British Association of Managers of Textile Works (Yorkshire Section), Halifax Commercial Bank Chambers, Tyrrel Street, Bradford.—Ezra Naylor, Chairman; John Wade and G. R. Gaunt, Vice-Chairmen; A. Greenlay, Secretary. Meetings, Technical College, Bradford. First Thursday in each month at 8 p.m., at Great Northern Hotel, Bradford.

British Cotton-Growing Association, 15, Cross Street, Manchester.—J. A. Hutton, Chairman; E. H. Oldfield, Secretary; W. H. Himbury, Manager.

Burnley Master Cotton Spinners and Manufacturers' Association, 7, Grimshaw Street, Burnley.—F. A. Hargreaves, Secretary.

Bury District Federation of Cotton Spinners and Manufacturers, 11, Cedar Street, Bury.—E. C. Rostron, Secretary.

Chorley Cotton Manufacturers' Association, Chorley.—Arthur Karfoot, Secretary, Park Villa, Chorley.

Cotton Employers' Mutual Liability Association, Ltd.—Sec., Fred. W. Tattersall, 17, St. Ann's Square.

Cotton Spinners and Manufacturers' Association, 12, Exchange Street, Manchester.—John Taylor, 12, Darwen Street, Blackburn, and F. A. Hargreaves, F.C.A., 7, Grimshaw Street, Burnley, Joint Secs.

Chorley Master Cotton Spinners' Association.—Arthur Karfoot, Secretary, Park Villa, Chorley.

Colne and District Coloured Goods Manufacturers' Association, 7, Grimshaw Street, Burnley.—F. A. Hargreaves, Secretary.

Cotton Trade Accidents Association, 17, St. Ann's Square, Manchester; Wm. Tattersall, sec.

Cotton Trade Insurance Association, Ltd., 12, Exchange Street, Manchester, and 12, Darwen Street, Blackburn.—John Taylor, sec. Tel.: 4450 City.

Cotton Trade Tariff Reform Association (incorporated with the *Tariff Reform League*, Manchester and District, and Lancashire, Cheshire, and N.W. Counties' Divisions), 32, Corporation Street, Manchester.—Cleveland Fife, sec.

Cotton Waste Spinners and Manufacturers' Association, 12, Exchange Street, Manchester.—F. A. Hargreaves, Secretary. Tel.: 4450 City.

Darwen Cotton Employers' Association.—J. Hollis, India Mills, Darwen, sec. Tel.: 57.

Darwen Cotton Manufacturers' Association, District Chambers, Darwen.—Thomas Hindle, sec. Tel.: 111.

Earby and District Manufacturers' Association.—Sec., John Hartley, Victoria Mill. Tel.: 10.

Employers' Federation of Bleachers, Printers, Dyers, and Finishers, 2, Cooper Street, Manchester.—F. B. Knott, sec.

Employers' Federation of Bleachers and the Bleaching Trade Advisory Board.—F. B. Knott, 2, Cooper Street.

Farnworth Cotton Spinners' Association.—W. G. Cryer, sec., Oak Mills, Farnworth. Tel.: 90.

Federation of Associations of Managers and Officials of Textile Works (comprising Blackburn and District Managers' Mutual Association; Bolton and District Managers, Carders, and Overlookers' Association; ditto, the Bury branch of same; British Association of Managers of Textile Works, Lancashire Section; and Preston and District Mill Managers' Association); H. Julius Lunt, sec., 27, Brazennose Street, Manchester.

Federation of Master Cotton Spinners' Associations, Ltd., 15, Cross Street, Manchester. Jno. B. Tattersall and Percy Ashworth, Vice-Presidents; John Smethurst, Secretary. Tel.: City 4245. Tel. Add.: "Employer."

Glossop, Hyde, and District Cotton Employers' Association—J. Hawkins, Broad Mills, Ltd., Broadbottom.

Haslingden Cotton Manufacturers' Association.—H. Warburton, Sec., 323, Acre Road, Haslingden.

Heywood and District Cotton Employers' Association, Ltd., W. E. Parker, 5, Hind Hill Street, Heywood.

Heywood and District Manufacturers' Association, 5, Hind Hill Street, Heywood.—W. E. Parker, Secretary.

International Federation of Master Cotton Spinners' and Manufacturers' Associations, 15, Cross Street, Manchester.—Sir C. W. Macara, Bt. (England), President; John Syz (Switzerland), Vice-Chairman; A. S. Pearse, Secretary; and John Smethurst, Hon. Secretary. Tel.: 1520 City.

Liverpool Cotton Association, Ltd., Cotton Exchange, Liverpool. Hugh L. Roxburgh, President; John R. Kewley, Treasurer; G. F. Higgins, Secretary; A. C. Nickson, Assistant Secretary; and H. Lloyd Jones, Manager.

Manchester and District Cotton Employers' Association.—W. G. Wilson, 4, Chapel Walks, Manchester. Tel.: City, 7095.

Manchester Association of Engineers, 2, Mosley Street, Manchester.—Frank Hazelton, Secretary.

Manchester Cotton Association, Ltd, 22, St. Mary's Gate, Manchester.—T. R. B. Hobson, President; J. K. Bythell, Vice-President; and H. Robinson, Secretary. Telephone 2830 City. Telegrams, "Arrivals, Manchester."

Manchester and District Engineering Trades Employers' Association, Royal Buildings, Mosley Street, Manchester.—Frank Hazelton, Secretary. T.N.: 2637 and 2638 "City."

Manchester Home Trade Association (N. Spencer and Co., 15, High Street).

Nelson and District Manufacturers' Association, 7, Grimshaw Street, Burnley.—F. A. Hargreaves, Secretary.

North Lancashire Master Cotton Spinners and Manufacturers' Association, 41, Guildhall, Preston.—J. Ward, Secretary.

Oldham Mill Managers' Technical Association.—John Holden, Sec., 174, Union Street, Oldham.

Oldham Master Cotton Spinners' Association, Ltd., District Bank Chambers, 12, Yorkshire Street, Oldham.—Jno. B. Tattersall, President; Edward Travis and R. H. Jackson, Vice-Presidents; Harold Cliff, Secretary; and John Pogson, Assist. Secretary. Tel.: 81.

Padiham Master Cotton Spinners and Manufacturers' Association, 7, Grimshaw Street, Burnley.—F. A. Hargreaves, Sec.

Preston and District Mill Managers' Association—F. C. Fielding, Charlotte Street, Fulwood.

Radcliffe and District Manufacturers' Association, 2, School St.—Clement Mather, Sec., Dingle Hurst, Outwood Road.

Ramsbottom and District Employers' Association, Irwell Mill, Ramsbottom.—L. C. Stead, Secretary.

Rawtenstall Cotton Spinners' Association, 11, Cedar Street, Bury.—E. C. Rostron, Secretary.

Rochdale and District Cotton Employers' Association, Ltd.—R. Stott, Sec., District Bank Chambers, Rochdale. Tel.: 696.

Rochdale and District Master Cotton Spinners and Manufacturers' Association, 7, Grimshaw Street, Burnley.—F. A. Hargreaves, Secretary.

Skipton Cotton Manufacturers' Association, 7, Grimshaw Street, Burnley.—Ernest Smith, A.C.A., Sec.

Society of Textile Industries and Cotton Spinners, 22, Rock Street, Oldham.—Thos. Sampson, Secretary.

Stockport and District Cotton Employers' Association.—Major C. Tyler, 37, Greek Street, Stockport.

Stockport Mill Managers' Association, Stockport.

Textile Institute.—President: Lord Rotherham; Secretary, Wm. Scott Taggart, M.I.Mech.E., 16, St. Mary's Parsonage, Manchester.

Yorkshire Master Cotton Spinners and Doublers' Association, Ltd., 12, Belvoir Gardens, St. Alban's Road, Halifax.—A. Hinchliffe, sec. Tel.: 1460 Halifax.

TEXTILE ASSOCIATIONS ABROAD

INDIA.

Ahmedabad Millowners' Association, Ahmedabad.—Hon. Sec., Shet Lalbhai Dalpatbhai, Saraspur Mftg. Co., Ahmedabad.

Bengal Chamber of Commerce, Calcutta.—H. M. Haywood, Sec., P.O.B. 280, Calcutta.

Bombay Mill Owners' Association.—R. E. Gregor-Pearse, sec.

Delhi Millowners' Association, Delhi.—Rai Bahadur Lalla, Shuknohndas, Pres.

Madras and Southern India Millowners' Association, Madras.—R. Lee, Hon. Sec., c/o Binny and Co., Ltd., Madras.

Upper India Chamber of Commerce (Cotton Section).—A. Shakespear, Sec., Cawnpore.

UNITED STATES OF AMERICA.

American Cotton Manufacturers' Association, Charlotte, N.C.—T. I. Hickman, President; C. B. Bryant, Sec.

Arkwright Club (Cotton Trade), Boston, Mass.—Edwd. Stanwood, Secretary, 201, Columbus Avenue, Boston.

Farmers' Educational and Co-operative Union (Planters), Dallas, Texas.—Chas. S. Barrett, Union City, Ga., President.

The National Association of Cotton Manufacturers, Room 57, International Trust Building, 45, Milk Street, Boston, Mass. C. J. H. Woodbury, Sec.

The National (Southern) Cotton Association, Atlanta, Georgia.—Harvie Jordan, President.

AUSTRIA.

Verein der Baumwollspinner Oesterreichs, 32/34, Maria Theresienstrasse, Vienna. Arthur Kuffler, President; August Beyer and Hans Haebler, Vice-Presidents; Dr. W. von Wymetal, Sec.

Verein der Baumwollweber Oesterreichs, Rudolfsplatz, 13a, Vienna, I.—Kaiserlicher Rat Ernst Ritter von Boschan; Kommerzialrat Dr. Ernst Marbach, Dr. O. von Bronneck, Sec.

BELGIUM.

Association Cotonnière de Belgique, Ghent.—Jean de Hemptinne, President, rue Charles V.; De Cnyf, 2, Quai des Moines, Ghent, Secretary.

Association Belge de Tissage, Ghent.—M. Fierens, Sec., 18, rue Joseph Plateau, Gand.

CHINA.

Cotton Millowners' Association of China, Shanghai.—Provisional Hon. Sec., James Kirfoot.

DENMARK.

Textilfabrikantforeningens, Odense.—Harry Dessau, Odense, Pres.

FRANCE.

Syndicat General de l'Industrie Cotonnière Francaise, 9, rue St. Fiacre, Paris.—F. Kuhwarth, Secretary.

Association Cotonnier Coloniale, Paris.—A. Esnault-Pelterie, President; C. Meunier, Secretary.

Syndicat Cotonnier de l'Est, Epinal (Vosges).—R. Laederich, Vice-President; D. Joubin, Secretary.

Syndicat Normand de la Filature de Coton.—G. Badin, Barentin (Seine Inferieure), President.

Syndicat Normand du Tissage de Coton, Rouen.—J. Gailliard, Barentin (Seine Inferieure).

Syndicat des Filateurs et Retordeurs de Coton du Nord, Lille (Nord).—Julien Le Blan fils.

Syndicat des Filateurs de Coton de Roubaix-Tourcoing.—L. Cavrois.

Syndicat de Roanne, Thizy et la Region.—Stephane Faisant, Pres.

Syndicat Cotonnier de Bolbec-Lillebonne.—G. Lemaitre, Pres.

Syndicat Picard des Industries Textiles.—G. Sydenham, Rouval-les-Doullens (Somme), President; Roger Barbet-Massin. Amiens (Somme), Vice-President.

GERMANY.

Deutsch-Levantinische Baumwoll-Gessellschaft m. b. H. Dresden—Franz J. Günther, 3, Blumenstrasse.

Industrie-Verein, Werdau i. S.—Direktor Alfred Kahle, Leubnitz-Werdau, President.

Kolonial-Wirtschaftliches Komitee, Berlin.—Karl Supf, Pariser Platz 7, Berlin, N.W., President (Member of the Colonial Council); Moritz Schanz, Chemnitz.

Verein Süddeutscher Baumwoll-Industrieller, Augsburg, Geh.—Kommerzienrat Heinrich Semlinger, President; Dr. E. Buettner, Secretary.

Vereinigung Sächsischer Spinnerei-Besitzer, j.P., Chemnitz.—Kommerzienrat Emil Stark, President.

Verband Rheinisch-Westphalischer Baumwollspinner, M.-Gladbach.—Kommerzienrat C. O. Langen, President.

Elsass-Lothringisches Industrielles Syndicat, Mülhausen (Alsace).—Geh. Kommerzienrat Schlumberger, President; Dr. Thomas, Sec.

HOLLAND.

Nederlandsche Patroonsvereeniging van Katoenspinners en wevers, Enschede.—R. A. de Monchy, jr., Hengelo, Hon. Sec.

ITALY.

Associazione Cotonieri Italiana, 41, Via A. Manzoni, Milan, President—Giorgio Mylius, Montebello 22; E. Cerconi, Sec.

Societa per la Coltivazione del Cotone nella Colonia Eritrea.—Alberto Moretti, Via Dante 14, Milan.

NORWAY.

De norske Tekstilfabrikanters Forening, c/o Paul Hofgaard, Esq., Fredrickshald.

PORTUGAL.

Associacao Industrial Portugueza, Lisbon.—H. P. Taveira, 236, rua da Palma.

Associacao Industrial Portuense, Oporto.—Jacinto Magalhaes, 36, rua da Saudade, Oporto.

RUSSIA.

Association de Manufacturers en Coton, Iljinka 21, Moscow.—Man. Sec., S. T. Popoff; Pres., P. P. Riabouschinsky.

Cotton Committee of the Moscow Exchange, Mjassnizkaja, Dom Kuznowa, Moscow.—R. von der Mühlen, Secretary.

Petrograd Manufacturers' Association, 27, Sogorodnü Prospect, Petrograd.

Komitee für Handel y Industrie, Lodz.

SPAIN.

Fomento del Trabajo Nacional, Barcelona.—J. Aguilera, Valencia 250, Barcelona, Secretary.

Sociedad de Fomento Fabril, Santiago.

SWEDEN.

Svenska Bomullspinneri-föreningens Ombudsman, Gothenburg, Victor Lidell, Sec.

SWITZERLAND.

Schweizer Spinner-, Zwirner- und Weber-Verein, Zürich.—J. H. Hermann Bühler, President; Eugen Egli, 9, Zeltweg, Zürich, Secretary.

JAPAN.

Japan Cotton Spinners' Association, 50, Ichi-chômé, Edobori minami-dori, Nishiku, Osaka.—Takeo Yamanobé, President; O. Shoji, Secretary.

THE AMALGAMATED ASSOCIATION OF OPERATIVE COTTON SPINNERS

Offices: 3, Blossom Street, Gt. Ancoats Street, Manchester.

SECRETARY: William Marsland (30, Berwyn Place, Canterbury Street, Ashton-under-Lyne).

Quarterly Representative Meetings, 4th Saturdays in March, June, September, and December.

DISTRICTS AND SECRETARIES.

Accrington and District—Black Horse Hotel, Abbey St.—1st Wed. in Jan, April, July, Oct.—Jas. Dewhurst, 50, Westwood St.

Ashton-under-Lyne Spinners—Spinners' Offices, Old St.—3rd Thurs in March, June, Sept, Dec, at 7-30.—E. Judson, 116, Burlington Street.

Ashton Twiners—Star Inn, Cotton St.—3rd Wed in Jan, April, July, Oct.—James Clayton, 32, Old Cross St.

Atherton—Bear's Paw Hotel—2nd Wed in each month—John Ainscough, 91, Bolton Rd.

Bamber Bridge—White Bull Inn—2nd Mon in March, June, Sept, Dec., and Mon after Rep. Mtg.—Thomas De Rome, 52, Station Rd.

Blackburn—Spinners' Institute, 9, St. Peter St.—2nd Thurs in month—James Johnson, 138, Accrington Rd., Blackburn.

Bollington Fine Spinners—Bollington Sunday School—Wed before Quar. Rep. Mtg.—Henry Hardy, Lord St.

Bolton—77, St. George's Rd.—2nd Wed. in each month—Peter Bullough.

Bradford—Trades Hall, 2nd Sat. in Jan, April, July, Oct.—Geo. E. Greenwood, 35, Hartington Terr., Lidget Green.

Brighouse—Oddfellows' Hall—2nd Sat in Jan, April, July, Oct.—H. Smith, Charles St., Lane Head.

Burnley—9, Bank Parade—Thurs before Quarterly Meeting—Henry Chisnall, 23, Bar St.

Bury and District—Textile Operatives' Hall—1st Thurs after 21st of month—A. E. Lees, 3, Mostyn St.

Chadderton—Unicorn Inn, Werneth—Wed following 2nd Tues in each month—J. Hilton, 199, Denton Lane, Hollinwood.

Chorley—28, High St.—Tues before 2nd Sat in March, June, Sept, Dec—C. Hodkinson, 26, High St.

Coldhurst—Willow Bank Hotel—2nd Wed after 1st Tues—R. Weston, 22, Caroline St., Oldham.

Darwen—Spinners' Institute, 78, Crown St.—2nd Thurs in March, June, Sept, and Dec.—H. J. Sanders, 8, St. John's St.

Dewsbury—Baptist School, Staincliffe—2nd Sat in Jan, April, July, and Oct.—Milford Shaw, 113, Moor Lane End, Dewsbury.

Droylsden—Cotton Tree Inn—2nd Mon in Jan, April, July, Oct.—Thomas Bertenshaw, 6, Duke St.

Elland—Temperance Schoolroom—2nd Sat in Jan, April, July, Oct—W. Shaw, 23, Middle Dean St., Halifax.

Failsworth—Secular Hall, Poll Lane—2nd Tues in each month—J. L. Kenworthy, Ashton Rd. East.

Farnworth—Market Hotel, Brackley St.—Tues before 2nd Wed in each month—Wm. Taylor, 100 Campbell St., Moses Gate.

Gregson Lane—Castle Hotel, 1st Mon after Rep. Mtg.—J. Almond, 8, Queen's Road, Walton-le-Dale.

Halifax—Friendly and Trades Club—2nd Sat in Jan, April, July, Oct.—W. Freeman, 21, Bath Place, Woodside.

Haslingden—Victoria Hotel—3rd Thurs in March, June, Sept, Dec.—T. Williams, 5, Carr Mill St.

Heywood—Trades Hall—1st Wed after 2nd Tues in each month—J. W. Shaw, 37, Tower Street.

Higginshaw—United Methodist Schoolroom, Halstead St—1st Wed after 2nd Tues in month—E. Birch, 383, Shaw Rd, Oldham.

Hindley—Dog and Partridge, Atherton Rd.—2nd Thurs in March, June, Sept, Dec.—J. Grime, 730, Atherton Rd, Hindley Green.

Hollinwood—Congregational School, Pump St.—2nd Tues evening in the month—Wm. Clough, 80, Drury Lane.

Huddersfield—Friendly and Trade Societies' Club, Northumberland St—1st Wed in month, 7-30—G. A. Hurst, 41, Northgate.

Hyde—Spinners' Institute, 29 George St—4th week in Jan, April, July, Oct—Arthur Williamson, 29, George St

Kirkham—Derby Arms Hotel—Mon before 1st Thurs in month—J. Kirley, 4, Garstang Rd. North, Wesham.

Lancaster—New Trades Hall, Queen's Square—3rd Thurs in March, June, Sept, Dec.—W. Gardner, 36, Victoria Terrace.

Lees (near Oldham)—Angel Inn—1st Wed after 2nd Tues in each month—R. Ashton, 19, Rhodes Hill, Lees.

Leigh—Bull's Head Hotel—2nd Mon in March, June, Sept, Dec.—John Cocker, 15, Henry St.

Macclesfield—Franklin Inn, Steeple St.—1st Wed. in Jan, April, July, Oct.—L. Hough, 15, York St., Buxton Rd.

Manchester—Crown Inn, Mill St., Ancoats—Friday before 2nd Sat in March, June, Sept., Dec.—T. Hanson, 45, Conran St., Harpurhey.

Middleton.—Bricklayers' Arms, Market Place—2nd Tues in each month—Benjamin Dyson, 153, Rochdale Rd.

Middleton Junction—Gardeners' Arms, Middleton Junc.—2nd Tues in each month—E. H. Ashworth, 22, Andrew Street.

Mossley—George Hotel—1st Wed in every month—Wright Mosley, 39, Arundel St.

Oldham No. 1—Spinners' Offices, Rock St.—Wed after 2nd Tues in each month—Thomas Iles, 109, Rock St.

Oldham No. 2—Duke of Edinburgh Hotel, King St—2nd Wed after 1st Tues. in each month—J. Bracewell, 49, Eldon St.

Oldham Twiners—Spinners' Offices, Rock St.—1st Wed after 2nd Tues every month—J. W. Jones, 139, Old Lane, Hollinwood.

Oldham Executive Council—Spinners' Offices, Rock St.—1st Tues in each month, 7-30—F. W. Birchenough, 274, Copster Hill Rd.

Oldham Roller Coverers—Royal George Hotel, Rochdale Rd.—2nd Friday in each month—Thomas Mills, 1, Wye St.

Padiham.—Spinners' Institute, Dove St.—2nd Thurs in each Quarter, 7-30—Robt. Bispham, 19, Cliff St.

Pendlebury—New Cross Inn, Swinton Hall Rd.—2nd Wed in Jan, March, April, June, July, Sept, Oct, Dec.—J. Ford, 84 Moss Lane, Swinton.

Preston—Spinners' Institute, Church St.—1st Thurs in every month—James Billington, Prospect House, Long Lane.

Rawtenstall—Assembly Rooms, Cloughfold—Last Friday of Jan, April, July, Oct.—James Wright, 55, Bank St.

Reddish—Houldsworth Working Men's Club—Quarterly—Wm. Eckersley, 15, Haddon Grove.

Ripponden—Chartist Room—2nd Sat in Jan, April, July, Oct—J. Dyson, 111, Bankfield.

Rochdale—Spinners' Institute, King St—1st Tues in month, 7-30. Quar. Mtgs.; 2nd Tues in March, June, Sept, Dec.—Charles Redfern, 85, Hamer Lane.

Royton—Village School, Chapel Lane—2nd Tues in month—Robt. Barlow, 33, Queen St.

Shaw and Crompton—Oddfellows' Social Institute, Farrow St.—1st Wed after 2nd Tues in each month—Saml. Taylor, 3, Salts Street, Shaw.

Sowerby Bridge—Cotton Operatives' Office—2nd Fri in Jan, April, July, Oct.—Arthur Gledhill, Dale Terrace.

Stainland—Holywell Green, Mechanics' Institute—2nd Fri. in Jan, April, July, Oct—Laurence Nutton, Beech Street, Stainland.

Stalybridge—Stamford Arms, Stamford St—1st Wed in each month—Samuel Sidebottom, 34, High St.

Stockport—Spinners' Institute, Wellington Rd.—2nd Thurs in every month—James Barnshaw, 13, Dawson St., Brinnington.

Tyldesley—Castle Hotel, Elliott St.—Thurs following 2nd Tues in March, June, Sept, Dec.—T. Sharples, 47, St. George's St.

Warrington—Waggon and Horses, Buttermarket St.—3rd Tues in every month—Arthur Eckersley, 7, Amelia St.

Waterhead—Plough Inn—1st Wed after 2nd Tues each month—Robert Bardsley 107, Raper St., Waterhead, Oldham.

Wigan—Bridgewater Arms, Wallgate—3rd Wed of Jan, March, April, June, July, Sept., Oct., Dec.—T. Coyle, 47, Hutton St., Worthington, Standish, Wigan.

Yorkshire Province—Cotton Operatives' Office, Town Hall Street, Sowerby Bridge—2nd Sat in Jan, April, July, Oct.—J. Bates, 14, Albert Road, Beach, Sowerby Bridge

THE AMALGAMATED ASSOCIATION OF CARD AND BLOWING ROOM OPERATIVES

Offices: 2a, Hodson's Court, Corporation Street, Manchester.

SECRETARY. Wm. Mullin, J.P.

DISTRICTS AND SECRETARIES.

Accrington.—Robert Kay, 24, Avenue Parade.
Ashton-under-Lyne.—W. Hy. Carr, J.P., Cardroom Offices, Old St.
[illegible]on.—Jos Edge, J.P., 77, St. George's Road.
Blackburn.—M. Brothers, 56a, Victoria Street.
Bury.—Councillor John Duckworth, J.P., Textile Hall.
Glossop (merged with Hyde).
Heywood.—Wm. Schofield, Trades' Hall, West Street.
Hyde.—Walter Gee, 144, George Street.
Macclesfield.—A. Bamford, 42, Bank Street.
Mossley.—Mr. M. B. Farr, 18, Stamford Road.
Oldham.—M. Connolly, 108, Union Street.
Rochdale.—J. J. Kingsley, 5, Baillie Street.
Stockport.—Frederick Parker, Textile Hall.
Wigan.—M. Carmody, 26, Caroline Street.

LOCAL ASSOCIATIONS OF COTTON OVERLOOKERS & OPERATIVES

(Principally Preparatory to Weaving, and Weaving)

Accrington—

Accrington Branch of Amalgamated Society of Beamers, Twisters, and Drawers: Peel Arms Hotel; Jno. Hindle, sec.

North-East Lancashire Card and Blowing Room Operatives and Ring Spinners' Association, 24, Avenue Parade, Accrington; R. Kay, sec.

Ashton-under-Lyne—

Ashton-under-Lyne and District Power-Loom Overlookers' Association, 7, Russell Street; James Waddicor, sec.

Ashton-under-Lyne and District Power Loom Weavers' Association: Weavers' Institute, Old Street; S. T. Goggins, sec.

Bacup.—The Bacup Weavers, Winders, and Beamers' Association, 91, Market Street, Robt. Green, sec.

Bolton—

Bolton Cotton Warpers' Society: Crown and Cushion Hotel, Mealhouse Lane, Great Bolton; Wm. Taylor, sec., 14, Kirkly Road.

Bolton Amalgamation of the Operative Bleachers, Dyers, and Finishers' Association: 19, Wood Street; Alfred Smalley, sec.

Bolton and District Power Loom Weavers and Winders' Association: (Cephas Speak, sec.), Spinners' Hall, 77, St. George's Road.

Beamers, Twisters, and Drawers' Association, Red Cross Hotel, Bradshawgate; Thos. Whitehead, 238, Settle St.

Bolton and District Power Loom Overlookers' Trade Sick and Burial Association: Balmoral Hotel, Bolton; John Bromiley, sec.

Blackburn—

Blackburn District Tape Sizers' Protective Society: Hart's Chambers, 2, Victoria St.; Jno. W. Ainsworth, sec.

Blackburn Amalgamated Power Loom Overlookers' Provident Association: Overlookers' Club, High Street, Blackburn (including Clitheroe, Great Harwood, Rishton, Padiham, and Clayton-le-Moors); Albert Fish, sec.

Blackburn and District Power Loom Weavers, Winders, and Warpers' Association: 1, Clayton Street; sec., Luke Speak.

Blackburn Beamers, Twisters, and Drawers' Association: Grimshaw Park; John Holt, sec., 52, Park Road.

Burnley—

Burnley and District Engineers' Society; Geo. Hindle, sec., 44, Cobran Street.

Burnley and District Weavers, Winders, and Beamers' Association, Charlotte Street; J. Hindle, sec.

Burnley Twisters and Drawers' Association (branch of the Amalgamated Association of Twisters, Drawers, and Machine Workers: Oddfellows' Central Club, Keighley Green; R. B. Watson, sec., 23, Bank Parade.

Burnley and District Loom Overlookers' Association: 17a, Market Street; J. Hargreaves, sec.

Burnley Tape Sizers' Protective Society, 5, Palace Street; John Spencer, sec.

Bury—

Bury Branch of United Association of Power Loom Overlookers.

Bury, Radcliffe, and District Weavers' and Winders' Association; W. Nabb, sec., Textile Operatives' Hall, Manchester Road.

Church—Church and Oswaldtwistle Weavers, Winders, and Warpers' Association: Weavers' Inst., Lock St., Oswaldtwistle; J. T. Wolstenholme, sec.

Chorley—

Chorley Amalgamated Beamers, Twisters, and Drawers' Association; A. Kirk, sec., 1, Victoria Terrace.

Clitheroe—

Clitheroe Weavers' Association: Weavers' Institute; A. H. Cottam, sec.

Clitheroe Beamers, Twisters, and Drawers' Association; David Brookes, 58, West View, Clitheroe.

Colne—

Colne and District Weavers, Winders, and Beamers' Association: Tower Buildings; T. Shaw, sec., 243, Keighley Road.

Colne and District Power Loom Overlookers' Association, 2, Knowsley Street; J. Hartley, sec.

Darwen—

Darwen Card and Blowing Room Operatives' Society (Joseph Bury, sec.), 46, Sarah Street.

Darwen Branch of the Amalgamated Tape Sizers' Protective Society: 65, Sandon Street; J. Roberts, sec.

Darwen Twisters and Drawers' Association (Peter Duckworth, sec.), Alexandra Terrace.

Darwen Weavers, Winders, and Warpers' Association: 21-23, Victoria St.; Jno. Parkington, sec.

Darwen Textile Warehousemen (John Marchington, sec.), 4, Willow Street.

Glasgow—

Glasgow and West of Scotland Power Loom Tenters' Society: 15, William Street, Greenhead; Robert Day, sec.

Great Harwood—

Great Harwood Weavers, Winders, and Beamers' Association: 8, Police Street; W. Hesmondhalgh, sec.

Great Harwood and District Society of Twisters and Drawers; R. H. Clough, sec., 5, St. Lawrence Street.

Haslingden—

Haslingden Weavers' Association: Weavers' Institute, Union Street; Geo. Whittam, sec.

Haslingden Beamers, Twisters, and Drawers' Association; John Tomlinson, sec., 64, Hud Hey Road.

Heywood—

Amalgamated Association of Beamers, Twisters, Drawers, & Machine Overlookers: Brian House, Bury Old Road; W. C. Robinson, sec.

Heywood and District Weavers, Winders, and Reelers' Association: Trades Hall; J. W. Ogden, sec.

Huddersfield—

Huddersfield Operative Cotton Spinners' Association; G. A. Hurst, sec.; Friendly and Trade Societies' Club, Northumberland Street.

Hyde—

Hyde, Hadfield, and Districts Weavers, Winders, and Warpers' Association: 27, George Street; Wm. Pope, sec.

Littleboro'—

Littleboro' Branch of United Association of Power Loom Overlookers, Red Lion Hotel; Matthew Taylor, sec.

Macclesfield—

National Silk Workers' Association, No. 1,360, T. Ches.: Trades Hall, Chatham St.; J. Hadfield, sec.

Hand Loom Silk Weavers' Association: Trades Hall, Chatham Street; Alfred Rowley, sec., 106, Great Night Street.

Middleton—

Middleton Branch of United Association of Power Loom Overlookers, 264, Whitworth Road, Rochdale; T. Walmsley, sec.

Nelson—

Nelson and District Weavers' Association: Pendle Street; William Ward, sec., 8, Vernon Street.

Textile Trades Federation of Nelson, Colne, Brierfield, and District: Weavers' Institute; Charles Tate, sec., Pendle Street.

Nelson and District Clothlookers and Warehousemen's Association: 8, Albert Street; Thos. McCall, sec.

Nelson and District Power Loom Overlookers' Society, Jude Street; Albert Smith, J.P., sec.

Nelson and District Association of Warp Dressers, 2a, New Brown Street; James White, sec.

Nelson Branch, Twisters and Drawers' Association: Weavers' Institute; F. Wilkinson, sec., 13, Gisburn Road, Barrowford.

Oldham—

Oldham and District Weavers and Winders' Association; J. Bell, sec., Weavers' Institute, Bartlam Place, Horsedge Street.

Padiham—

Amalgamated Association of Beamers, Twisters, and Drawers: Joseph Rawcliffe, sec., 10, Albion Street.

Padiham and District Weavers, Winders, and Warpers' Association: Weavers' Office, Sowerby St.; David Russell, sec.

Padiham and District Managers, Carders, and Spinning Overlookers' Association: 3, Burnley Road; R. Pollard, sec.

Preston—

Preston Powerloom Weavers' Association: Weavers' Institute; Luke Park, sec., Walker Street.

Preston Beamers, Twisters, and Drawers' Association; R. Swarbick, sec.

Radcliffe—

Radcliffe and District Weavers and Winders' Association; Wm. Nabb, sec., 65, Seymour Street.

Ramsbottom—

Ramsbottom and District Weavers, Winders, and Warpers' Association: 5, Buchanan St.; T. Y. Sutcliffe, sec.

Ramsbottom Branch of United Association of Power Loom Overlookers: Wm. Longworth, President, 17, Cemetery Road; T. Walmsley, sec., 8, Pullman Street, Rochdale.

Rawtenstall—

Rossendale Weavers, Winders, and Beamers' Association: 245, Bacup Road, Cloughfold, near Manchester; Jno. Farren, sec.

Rochdale—

Rochdale Branch of Amalgamated Society of Mill Warpers: Warpers' Club, 5, River St.; Jno. S. Isherwood, sec.

Rochdale and District Branch of Northern Counties Amalgamation of Weavers, Winders, and Beamers: 5, Cloth Hall St.; J. H. Holden, sec.

Rochdale and District Association of Warp Dressers: 10, Heights Lane; Ben Hoyle, sec.

Rochdale Branch of the Amalgamated Association of Beamers, Twisters, Drawers, and Machine Workers: John J. Taylor, 34, Oswald Street.

Rochdale Branch of United Association of Power Loom Overlookers: Thomas Walmsley, sec., 8, Pullman Street.

Stockport—Stockport and District Weavers, Winders, Warpers, and Reelers' Association: Trades Hall, Chestergate; John P. Riding, sec.

Todmorden—

Northern Counties Amalgamated Society of Weavers (James Wilkinson, sec.).

Todmorden Power Loom Overlookers' Society; W. H. Jackson, president.

Todmorden and District Weavers and Winders' Association: Calder Bank, Burnley Road; W. J. Tout, sec.

OTHER COTTON TRADE UNIONS & SOCIETIES

Amalgamated Association of Engineers, Carders, and Mule and Ring Frame Overlookers: 55, Manchester Road, Shaw, Oldham; Joseph Dawson, sec.

Amalgamated Association of Beamers, Twisters, Drawers, and Machine Workers: 210, Ashfield Road, Rochdale; H. Clough, sec.

Amalgamated Society of Mill Warpers: Warpers' Club, 5, River Street, Rochdale; Jno. S. Isherwood, sec.

Amalgamated Weavers' Association, Ewbank Chambers, 17, St. James St., Accrington; Joseph Cross, sec.

General Amalgamated Textile Warehousemen (including Cloth and Yarn Warehousemen): Edward Strong, sec., 356, Audley Range. (Branches at Accrington, Ashton-under-Lyne, Bacup, Bolton, Blackburn, Bury, Burnley, Chorley, Colne, Darwen, Great Harwood, Haslingden, Hyde, Macclesfield, Nelson, Oldham, Padiham, Preston, Rawtenstall, Rochdale, and Todmorden.

General Union of Associations of Loom Overlookers: "Belvedere," Oakbank Avenue, Moston, Manchester; J. E. Tattersall and Edward Duxbury, secs.

Lancashire Amalgamated Tape Sizers' Protective Society: Hart's Chambers, 2, Victoria Street, Blackburn; Jno. W. Ainsworth, sec.

Northern Counties Amalgamation of Weavers, Winders, and Beamers: 5, Cloth Hall Street, Rochdale; James H. Holden, sec.

Northern Counties Textile Trades' Federation: 243, Keighley Rd., Colne; T. Shaw, sec.

United Association of Power Loom Overlookers: 264, Whitworth Road, Rochdale; Wm. T. Walmsley, sec. (Branches at Todmorden, Littleboro', Middleton, Bury, and Ramsbottom.)

United Textile Factory Workers' Association: Ewbank Chambers, Accrington; Joseph Cross, sec.

HOLIDAYS IN COTTON DISTRICTS

☞ The SUMMER holidays given below are in some few cases liable to slight alterations. Travellers purposing to visit the districts a week or so before or after the dates mentioned, are therefore advised to assure themselves that no alterations have been made.

Accrington

New Year's Day.
Good Friday and following day.
Whitsun—Monday and Tuesday.
August—Stop Friday night after first Thursday, until Monday but one following.
Christmas Day.

Ashton, Dukinfield, and Hurst

First Saturday in the year.
Good Friday, following day, and Easter Monday.
Whitsun—Friday and Saturday.
Wakes—Friday night to Monday but one following. (Wakes Sunday is first Sunday after Aug. 15.)
Christmas Day (when a Saturday, to be considered a day of ten hours. When a Sunday, the following Monday to be a holiday).

Atherton

New Year's Day.
Good Friday and day following.
July—First Saturday and week following. (Stop on Friday night prior to the first Saturday.)
September—Second Monday and following day.
Christmas Day.

Blackburn

Good Friday and Saturday.
Whit Monday and Tuesday and previous Saturday.
Mills stop on Friday night following August Bank Holiday until Monday but one following.
September—Third Saturday and Monday following.
Christmas Day and New Year's Day.

Bollington

New Year's Day.
Good Friday and day following.
Whitsun—Stop Thursday noon till Monday following.
July—Wakes holiday, commencing week-end before last Sunday (*i.e.*, stop Friday night until Monday but one following).
Christmas Day.

Bolton, Horwich, and Westhoughton

New Year's Day
Good Friday and day following.
June—Stop last Friday in June until Monday but one following.
September—First Monday and Tuesday.
Christmas Day
(Bolton bleaching trade holidays also include greater part of Whit Week, owing to closing of Manchester warehouses.)

Holidays in Cotton Districts.—Continued.

Bradford

Easter Monday and Tuesday.
Whitsun—Monday and Tuesday.
August Bank Holiday.
Christmas Day and day following.
(It is almost the universal custom in Bradford, that in addition to the holidays above, the operatives have one week holiday.)

Burnley

Good Friday and day following. Whit Monday.
July—Saturday after first Thursday, and following week
September—Monday after first Saturday and following two days.
Christmas Day and Boxing Day.

Bury and Elton

New Year's Day. Good Friday.
Whitsun—Friday and Saturday and following Monday.
August—First Saturday after Bank Holiday, and whole of following week.
Christmas Day.

Chorley

New Year's Day.
Good Friday and day following Whit Monday.
July—Third Saturday till following Monday week.
September—Second Monday, Tuesday, and Wednesday.
Christmas Day. (When New Year and Christmas Days fall on a Sunday, the following days to be holidays.)

Colne

Good Friday and day following.
Whitsun—Monday and day following.
Fourth Saturday in July and following week.
Second Saturday in September.
Christmas Day and day following.

Darwen

New Year's Day.
Good Friday and following Saturday.
July—Stop on Friday noon previous to third Monday, until following Monday week.
September—Stop on Friday night prior to second Mon day until following Thursday morning.
Christmas Day.

Droylsden and District

Good Friday and day following, and Easter Monday.
Whitsun—Thursday afternoon, Friday and Saturday.
Wakes—From Friday night to Monday but one following. (Wakes Sunday is first Sunday after August 15.) Christmas Day.

Farnworth

New Year's Day. Good Friday and day following.
Stop last Friday night in June. until Monday but one following.
September—First Monday and Tuesday.
Christmas Day.
Extra two days granted, not yet fixed.

HOLIDAYS IN COTTON DISTRICTS.—Continued.

Great Harwood

New Year's Day.
Good Friday and Saturday.
Whitsun—Sat. before Whit Sunday; Monday and Tuesday.
August—Week's holiday, commencing third Saturday.
Christmas Day.

Haslingden

New Year's Day.
Good Friday and following day.
Whitsun—Friday and Saturday after Whit Sunday,
July—Third week.
September—First Monday.
Christmas Day.

Hindley

Good Friday and following day.
Whit Monday.
August—First Monday and five following days.
Christmas Day and New Year's Day.

Huddersfield

No official holidays, but 105½ hours is agreed upon, each firm making its own arrangements.

Hyde

Good Friday, Easter Saturday, and Monday.
Whitsun—From Thursday noon until Tuesday following.
First Friday after August 15th to Monday but one following.
Christmas Day and Boxing Day.

Lancaster

Easter—Saturday before Easter Sunday, and Monday and Tuesday.
Whitsun—Same as Easter.
August—A full week, commencing first Saturday.
Christmas Day and two following days.

Leigh

Same as Tyldesley.

Macclesfield

Good Friday, day following, and Easter Monday.
"Barnaby" Saturday (June 21 or Saturday nearest thereto) and week following.
Wakes—Monday and Tuesday. (Wakes Sunday is September 29, or first Sunday after that date.)
Christmas Day and Boxing Day.

Middleton

Easter Monday and Tuesday.
Whitsun—Whit Friday and Saturday, and following (Trinity) Monday.
Wakes—Stop Friday night till following Monday but one.
August—Last Saturday but one.
Christmas Day.

Holidays in Cotton Districts.—Continued.

Middleton Junction

Easter Monday and Tuesday.
Whitsun—Friday and Saturday and following Monday.
August—Stop for Oldham Wakes (from last Friday till Monday but one following). Christmas Day.
Two extra days granted, which are not yet fixed.

Mossley

New Year—First Friday and Saturday in New Year (except when December 31 and January 1 are Friday and Saturday). New Year's Day is not a holiday except it be Friday or Saturday. as above. Easter—Friday and Saturday.
Whitsun—Friday and Saturday.
Wakes—Last Saturday in July, and following week.
Christmas Day.

Nelson

Good Friday and day following.
Last Friday night in June and following week.
Second Monday in September and two following days.
Christmas Day.

New Mills, Strines, Hayfield, etc.

September—Stop first Saturday for a week.

Oldham

Easter Monday, and either Easter Tuesday or Good Friday—at the option of the employer.
Whit Friday and Saturday, and following Monday
August—Last Saturday and following week.
Christmas Day.

Padiham

Good Friday and day following.
Whitsun—Monday and Tuesday.
July—Stop last Friday night until Monday but one following.
Stop third Friday night in September until following Tuesday morning at 6-0. Christmas Day.

Pendlebury

New Year's Day. Good Friday and day following.
Whitsun—Thursday, Friday, and Saturday.
August—The Bank Holiday week. Christmas Day.

Preston

Good Friday and following day.
Whitsun—Whit Monday, Tuesday, and Wednesday.
August—Full week from second Monday.
Christmas and Boxing Days.

Rawtenstall

Easter—Good Friday and Saturday following.
Whit Week—Friday, Saturday, and Monday.
July—Fourth Saturday and following week.
September—First Monday and Tuesday following and previous Saturday. Christmas Day.

Reddish

New Year's Day. Good Friday and day following.
Whitsun—Thursday, Friday, and Saturday.
Friday night previous to second Sunday in August until Monday but one following.
Christmas Day.

Holidays in Cotton Districts.—Continued.

Rishton

Good Friday and Easter Saturday.
Whit Monday and Tuesday.
July—Third Saturday and following week.
Also first Saturday in Sept., and following Monday.
Christmas Day.

Rochdale

Good Friday and following day.
Whitsun—From Thursday noon until Monday night of following week.
Wakes—Saturday after second Sunday in August and following week. Christmas Day.

Royton

Easter Monday and Good Friday or Easter Tuesday.
Whitsun—Friday, Saturday, and following (Trinity) Monday.
August—First Saturday and all of following week.
Christmas Day.

Shaw and Crompton

Easter Monday, and either Tuesday or Good Friday.
Whit Friday and Saturday, and following Monday.
August and "Wakes" Holiday: First Saturday after Aug. 13th—Friday night until following Monday but one.
Christmas Day.

Sowerby Bridge and Ripponden

Easter Monday.
Whitsun—Monday and Tuesday.
August—A full week.
Christmas Day.

Stalybridge

Easter Saturday and Monday.
Whitsun—Friday and Saturday.
Wakes—Friday night to end of following week (Wakes Sunday is on the second Sunday in August).
Christmas Day and Boxing Day.

Stockport and Whaley Bridge

Easter Saturday and Monday.
Whitsun—Friday and Saturday.
August—Full week following second Sunday.
Christmas Day and following day.

Tyldesley

New Year's Day.
Good Friday and following day.
Friday night previous to first Saturday in July and following week.
Second Monday and following day in September.
Christmas Day.
Two extra days granted, but not yet fixed.

Wigan

New Year's Day.
Good Friday.
Whit Monday.
August—Week commencing first Monday.
Christmas Day.

INDEX

NOTE.—Names or Designations of Fabrics, and Definitions of Textile Terms, are not included in this Index. They will be found in the **Glossary** on pp. 383-399, arranged alphabetically.

Y

Marsden & Co. Ltd., Mercury Works, Manchester.

Date Due
